Standard Size, 9 x 12. JUNE 22, 1899. Price Six Cents.

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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE AMERICAN MACHINIST PRESS,

Vol. 22. 218 WILLIAM STREET, NEW YORK. No. 25.

Contents and Index to Advertisers, Page 10.

Here is our new Screw Machine.

We have five sizes of this design, with wire feed, capacity as follows: No. 0—9-16″, No. 1—13-16″, No 2—1 1-16″, No. 3—1 5-16″, No. 4—1 9-16″. All sizes can be furnished with or without automatic chuck, wire feed, oil pump and oil pan. The two larger sizes can be furnished with geared friction head, the others with plain head only. No. 0 has lever feed for turret slide.

There is no lost motion in our new wire feed; it feeds the full throw of the lever—the spring does it. Our new chuck is forged on the end of the spindle and reduces the overhang about one-half. This feature we originated for use on our hub forming and drilling machine and it proved so successful that we have adapted it to our screw machines. Of course when a machine is ordered without wire feed we furnish the regulation male threaded spindle.

See the adjustment for the back tool post and notice the cut-off gib.

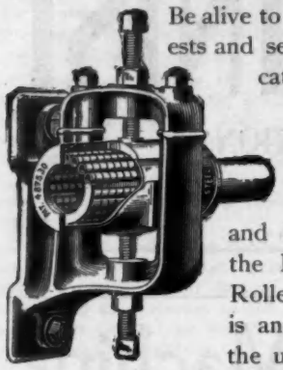
One of our best things is not shown here; you must send for our catalog to see the picture—it's our countershaft. We had so much trouble with the countershafts on tools in our shop that the boss got to swearing; swore so much that it got to coming easy and the small boy at home got to swearing; this *was* serious. One of our friends is a doctor. "Remove the cause," he says, meaning the boss (he considers this a great joke). Well, we went at it and designed a new hanger, adjustable, universal and self-oiling; then we made a new friction pulley. No more trouble, no more swearing, and the boy goes to Sunday school. We furnish these countershafts with all of our machines or sell them separately. We build to order machines up to 3″ capacity through the wire feed and with all sorts of special attachments. We have some other good things. If you don't send for our catalog it may be your loss as well as ours.

THE PEARSON MACHINE COMPANY,

Cable, "Pearson," Chicago, Lieber's Code. *37 West Randolph Street, Chicago, Ill., U. S. A.*

Walter H. Foster, 126 Liberty St., New York; J. W. Cregar, The Bourse, Philadelphia; McDowell, Stocker & Co., Chicago; Gustav Diechmann & Sohn, Berlin; B. A. Hjorth & Co., Stockholm.

"Live and Learn."



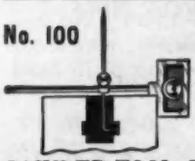
Be alive to your interests and send for the catalog of the **Hyatt Roller Bearing Co.,** and learn what the Flexible Roller Bearing is and who are the users.

Hyatt Roller Bearing Co.,
HARRISON, N. J.
133 Liberty Street, New York.

The Little Leaks

that are so small as to be hardly noticeable are important and should never be lost sight of. For instance, there's that little matter of oil that's thrown out on chips, bolts, nuts, etc.—ever think how much money you throw away every year in that way? Aside from being discolored, that oil is practically as good as it ever was, yet it's thrown away. No shop that uses as little as three barrels of oil per year, can afford to be without the means of reclaiming such oil for further use—a Roper Centrifugal Oil Separator. Let us tell you more about it.

American Tool & Machine Co.
BOSTON, MASS.
Founded 1845.
Incorporated 1864.



NEW SURFACE GAUGE
No. 100
PERFECT ADJUSTMENT.
UNEQUALLED SCOPE.
Price with 6 and 10 inch spindle, $2.50.
MADE BY THE
SAWYER TOOL CO., Fitchburg, Mass.

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TAPPING MACHINES
4 Sizes and Styles.
We also make the neatest Bench Drills and Grinders on the market.
St. Louis Machine Tool Co.
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This is Gas Forge No. 2....

It's special usefulness is in dressing and hardening tools and small forgings, and for this use there is nothing better. . . .

Like all the other products of the American Gas Furnace Co., this forge is all ready for business as soon as the gas connections are made, and nobody has to do any loafing on its account.

The smoke and dirt and ashes-emptying bothers that are inseparable from the ordinary forge, are entirely eliminated in these Gas Forges, and instead of getting as many different degrees of heat in an hour's time as there are minutes in the hour, they maintain a uniform and easily regulated heat that enables you to tell exactly what results you are getting without any guessing about it.

We've some books that tell the whole story, and we should be glad to send you one of them.

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23 John Street,
New York.

Chas. Churchill & Co., London and Birmingham.
Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm, New York.
H. Gnaenzer & Perreaud, Paris.

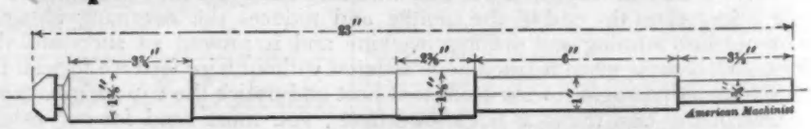
The Time to Get Ready

for lots of work is before the work comes. You don't always know when it's coming, so it's a good scheme to be ready all the time.

The best way to be ready for lots of pipe cutting and threading is to buy a Forbes Die Stock.

Better send for the Catalog to-day.

CURTIS & CURTIS, 66 Garden St., Bridgeport, Conn.

There's A Lot of "Duplicate" Work Turned Out

Soft steel shaft. Dimensioned sizes reduced .005" Finished 20 minutes.

that is'nt duplicate work at all, for the simple reason that one piece of the work differs perhaps the thousandth part of an inch from another. That kind of "duplicate" work won't go. The most infinitesimal variation would be fatal to the success of the machine of which that particular piece was a part.

If you have duplicate work to do that requires grinding, the Landis Grinder is the machine to do it on, because Landis duplicates are duplicates. Catalog full of points on grinding and showing Landis Grinders, free.

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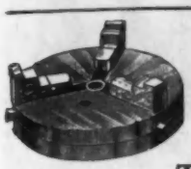
Hill, Clarke & Co., Boston and Chicago.
C. W. Burton, Griffiths & Co., London.
Walter H. Foster, Manager, New York.
Ad. Janssens, Paris and Brussels
Schuchardt & Schutte, Berlin, Cologne, Vienna, and Brussels.



YOU NEED CHUCKS

For your Lathes, Grinding Machines, Milling Machines, Screw Machines, Upright Drills, Cutting-off Machines, Drill Lathes, Boring Mills, Etc., Etc.

DO LIKE THOUSANDS AND SEND YOUR ORDERS TO US.

THE E. HORTON & SON CO.,

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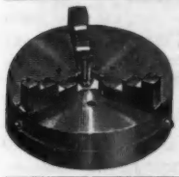
"Cushman" Chucks.

We manufacture ten distinct styles of Lathe Chucks, four styles of Drill Chucks, Centering Chucks, Face Plate Jaws and Chucks for special service. Send for new catalog and discount sheet.

The Cushman Chuck Co.

Hartford, Conn., U.S.A



Skinner Chucks.

Independent and Universal Chucks, Combination Lathe Chucks with patent reversible jaws, Drill Chucks, Planer Chucks, and Face Plate Jaws.

Skinner Chuck Co.,

New Britain, Conn.

Send for Catalog.

94 Reade Street, New York.

No Big Bites

taken out of drill shanks that are held by the Reid Chuck; yet the "Reid" holds them so they can't slip. Read the book about Reid Chucks.

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Independent, Solid Shell, Solid Reversible Jaw.

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The only mechanically correct automatic Die Head on the market. All leverage entirely overcome. Makes a full and perfect thread in one cut, and besides it can be accurately adjusted. Saves 50 per cent. in time and wear over solid dies. Made for cutting from No. 17 wire gauge to 6 in. diameter, and arranged for any style of thread. Adopted by all principal manufacturers of bicycles and bicycle fittings throughout the country. WHY? Write us for particulars and prices.

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Successor to C. W. LeCount,

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Agents: Chas. Churchill & Co., Ltd., London, England.

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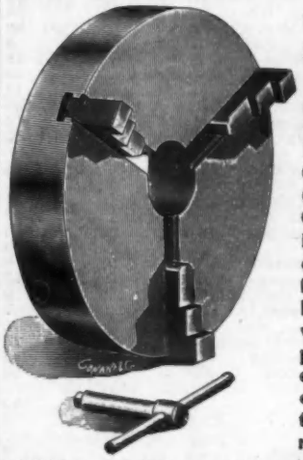
Trump Bros. Machine Co.,

Manufacturers,

Wilmington, Del., - - - - U. S. A.

For sale by Chas. Churchill & Co., Ltd., London, Eng.



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It's our Champion Geared Scroll Chuck, and it's a good one. Our free Chuck Book tells why, and the price. We can fill orders on the day they're received.

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NEW LONDON, CONN.

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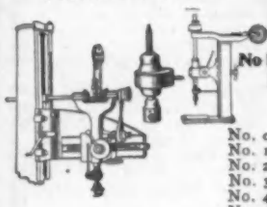
Errington

AUTO-REVERSE

Tapping Chuck

Drives tap in, stops automatically at bottom of hole and backs tap out (quick return) without stopping or reversing drill press spindle.

Either Friction or Positive Tool Holder.



Fits Socket of ANY Drill Press.

No Backing Belt.

No Special Taps.

No Extras.

No. 0 taps 1-16 to 3/8.
No. 1 taps 3/8 to 3/4.
No. 2 taps 5-16 to 1.
No. 3 (pipe) taps 1/4 to 1.
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No. 5 taps 1/2 to 2.

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Tools changed and friction adjusted while spindle is rotating without danger to operator.

Drills the hole, taps it and then sets the stud in, all without stopping or reversing drill press and without moving work.

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In the Pratt Chuck the jaws have only to hold the tool perfectly true; the positive driver does the driving. It can't slip even if the jaws are not tightened

It pays to have tools that will always keep at work.

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Send for Booklet.

Hampden Corundum Wheel Co. Vitrified Silicate Elastic **Emery Wheels,** Safety Collars, Wire Webbing, Grinding Machines, Brightwood Mass.

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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION

VOLUME 22 NEW YORK, THURSDAY, JUNE 22, 1899 NUMBER 25

Published at 218 William St., New York,
Every Thursday by the

American Machinist Press.

[INCORPORATED.]

JOHN A. HILL, President and Treasurer.
A. LEIGHTON DONNELL, Sec'y.

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Never address individuals, send all business communications to the American Machinist Press. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription Price:

$3 per year in advance, postage paid in North America.
$4 per year in foreign countries, postage prepaid.
No back Numbers beyond current year.
For Sale by Newsdealers, generally.

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Entered at New York P. O. as second-class mail matter.

Starting Engines and Tools.

A tool builder speaking the other day of guarantees on tools and test trials of them, said he had learned a valuable lesson during his steam-engineering experience. Formerly he contracted for and put in a great many steam plants; his contracts often covering the entire plant and everything pertaining to it, including the engine and boiler house. He found it always best to steadily refuse to get up steam and turn the engine over until every minute detail of the plant was known to be just as nearly in perfect condition for continuous running as it was possible to have it. We all know that the tendency is to "see the wheels go round" at the earliest possible moment, and engines are often started up under steam, simply to allay someone's impatience, when it is known that before continuous running can be done, a lot of joints must be tightened up, some repacking must be done and various finishing touches be put on here and there. The engine runs, say, for half a day or so, and is then shut down for a week or more, perhaps, while this work is being done. Then, usually when the final start is made and a settlement asked for, perhaps the proprietor is suspicious. "The engine has been started before, but did not keep going. You have been tinkering around here for a week or so fixing things, and how do I know that this is the real start, or that there may not be a lot of other things to do to the plant before it is perfect?"

On the other hand, if the engine does not start until every possible point has been looked after and known to be right, and if it then goes off and keeps running for a day or two with nothing to tinker the effect is very different and much better. The owner will probably think and say that things were a little slow in getting started, but that they are evidently all right now that they are started, and a settlement is much more readily effected.

Our friend now makes a machine tool which when operated on certain stock, with new lard oil for a tool lubricant, with belts of certain width running on pulleys which give the proper speeds, will turn out a certain number of pieces of work per day. These machines are sometimes sold under a guarantee to do this, and the men who are sent out with them are instructed not to start work under any circumstances whatever until the conditions of the test, as set down in the contract, are complied with in every minute detail. If 4-inch belts to the counter-shaft are specified 3½-inch belts will not do; new lard oil being specified, that which has been long in use and been through the extractor numberless times is rejected; a hard bar of stock is immediately taken out of the machine as soon as its hardness is manifested, and no attempt is made to fulfill the guarantee until every condition is precisely complied with, and pains are taken to specify every condition in the contract so that there can be no misunderstanding about them. When an attempt has been made and failure results it is hard to make excuses that will be satisfactory, and it is much better not to make an attempt until it is known that all conditions are just right and then make the first attempt a successful one.

The Worship of Hand Work.

In a recent issue "Engineering" discusses editorially the question of "American Competition and the Trusts" and concludes that there is still hope for British manufacturers in this market "provided only the Americans will help us by squeezing the consumer enough."

In the same issue there is published an account of an exhibition at Crystal Palace, in which account appears the following passage:

"To a mechanic one of the most interesting stands is that occupied by Mr. Charles Lancaster, of 151 New Bond street, W., the famous maker of high-class sporting guns. It is a truism in mechanical engineering that whilst good machine work is better and cheaper than good hand work, the very best work can only be done by hand, or at least must be hand-finished and adjusted. Mr. Lancaster's guns are made almost entirely by hand throughout, the milling tool being hardly used, and the metal reduced to form almost entirely by chisel, file, float, or broach. The work, when finished, is of superlative excellence, and many of the operations are shown in actual progress at the stand. The only machine exhibited is one for barrel boring, and a second for rifling. Other machines are, however, used at the actual factory, as a considerable amount of lathe-work has to be done."

In this passage it seems to us there is more light on the question of competition than is thrown upon it by the editorial article of our contemporary. Here a man who should make a virtue of chipping and filing parts of guns to shape without using machines would be laughed at, and practically none could be found who would believe that guns so made are one whit better than those on which all hand work, other than that really needed to secure accuracy of fit and beauty of finish, is avoided. The gun maker referred to, no matter what the excellence of his product may be, belongs to a bygone period, and the fact that his methods find endorsement in England speaks volumes.

The Equipment of Tall Office Buildings in New York City.

Tall office buildings are at the moment a prominent feature of New York City, but they cannot fail to find favor in all large cities, and the valuable collection of data concerning them in the paper by Reginald Pelham Bolton, at the recent Washington meeting of the American Society of Mechanical Engineers, cannot fail to be of interest to a wide circle of readers. We are able to give only an abstract of the contents of this paper.

The cost of land in lower New York City has rapidly increased of late years, going in one or two instances above $300 per square foot. Such values naturally

call for a large return from the building occupying the site. High rentals had the reflex effect of driving tenants to less advantageous locations in rear streets until the hight attainable in the modern buildings effected a combination of improved accommodation at a reasonable price. The competition between the various buildings has brought the minimum rate down from $3 per square foot per annum to below $2, and includes in this charge light, heat, attendance, cleaning and, of course, elevator service.

The increased hight of the downtown buildings referred to has added to the inhabitable area not less than 7,500,000 square feet. Illustrating the relative increase of value obtained by hight, the four and five-story buildings occupying the site of the present German-American Building represented a renting area of not more than 6,000 square feet per floor, which at the old rates of $3 per square foot per annum may have produced a gross rental of as much as $70,000 per annum when filled, but even this represented only 6 per cent. on the real value of the land alone. The new building has a net renting area of about 7,000 square feet per floor, producing on fourteen upper floors, even at the low average of $1.60 per square foot, $156,000, in addition to which are two large ground-floor banking parlors producing about $17,000 and $12,000 per annum respectively, also a basement restaurant bringing in $3,000, or a gross return of $188,000 per annum, an increase of two and a half times as much as the old buildings. On a cost for building and equipment of $650,000, and of land $937,000, or $1,587,000 in all, a gross return of nearly 12 per cent. is thus attained. The cost of management, operation of equipment, and city taxes naturally form a large increase on the same items in old buildings, but under good management and economy do not exceed 50 per cent. of the gross rental. It will be evident that the economical operation of the equipment forms a decided factor in the net balance available for interest.

The sanitary appliances in the older buildings were and are extremely behind the times, and have in numerous cases been the cause of tenants' removal. The old three and four-story buildings on the site of the Bowling Green Building, from the above causes, became unremunerative and some were closed up to avoid taxation. The site, which fronts 157 feet on Broadway, extends 170 feet through to Greenwich street, and was valued at a million dollars by the building company. On this site the Bowling Green Offices has been erected, which is the largest commercial office building in New York City, being 240 feet 6 inches average hight from street levels, and of a gross content of 4,915,000 cubic feet, with a floor area of 20,555 square feet on fifteen upper floors, and of 32,000 square feet on the ground floor and first basement, the sub-basement being devoted to mechanical services and storage. In this instance the increase in acreage has been enormous, the original 80,000 being raised to 367,500 square feet, or fully four times greater renting area than before. The total cost of the building was close on $2,000,000, and owing to the remarkable economy of its equipment and management it has been able to pay its way when not more than five-eighths occupied.

The cost of average steel-framed sixteen-story office buildings complete with equipment, and inclusive of a moderate amount of decorative ouside treatment in stone machine moldings or in terra cotta, without hand stone carving, is 36 to 40 cents per cubic foot of its gross cubic content, outside measurement. The excessively high buildings cost more, also those with expensive adornments. The relative cost of the mechanical appliances, including power, elevators, heat, light, and sanitation, is approximately one-seventh of the above. The total cost of mechanical appliances in a building of sixteen stories, basement, and sub-basement, say 6,000 square feet renting area per floor, was $82,000.

Or in detail:

	Cost.
Chimney	$1,200 to $2,500
Boiler Plant	9,000 to 11,000
Four to six elevator plant	28,000 to 40,000
Heating appliances and piping	14,000 to 17,000
Electric wiring and switchboard	9,000 to 15,000
Engines and generators	8,000 to 10,000
Sanitation and fixtures	12,000 to 15,000

The effect of an increase in the cost of these appliances, if the same be productive of economy and advantage in operation, is very much less, in proportion, than its importance to the owner. For instance, the difference in the above comparative costs would amount to $26,000, say 4½ per cent. on gross cost of building, which would represent fully 50 per cent. more convenience and the best appliances for economy throughout. It has, however, been difficult at times to induce owners to spend on economical appliances a small fraction of the sum laid out on ronremunerative outside or interior adornment.

The difference between a compound and a triple-expansion pump may be, say, $1,500, and be begrudged, while the difference between marble trim and other substitutes in the hall will be $15,000 and be freely expended.

These are difficulties met by engineers everywhere, yet in no case do they appear so forcibly. It is satisfactory to relate that such instances have been rather due to the present faulty system of letting general contracts inclusive of machinery than to the owners' shortsightedness as regards the advantage offered.

The lower portion of New York City is composed of rock and sand, the rock being very irregular in outline, but roughly composing a ridge or hump on the line of Broadway, often dropping off abruptly. The sand is the floor of the glacial river beds east and west, and is firm and affords a good foundation. At the extreme end of the promontory and along the west shore there is a good deal of made ground, but only one of the tall buildings with which the author has been associated trenched upon this, and in that case was carried below its level. Where the sand overlays the rock in a shelving form the foundations are carried to the rock, but a number of buildings exceeding 200 feet in hight have had their columns set on isolated concrete piers laid on the sand-bed.

Such piers are usually 6 feet square at the base, are 2 to 4 feet thick; on top is set the shoe of the column upon a plate about 4 feet square.

The columns forming the walls are similarly treated, but the piers are usually united by a footing of concrete on which the curtain walls are run up. These piers have to be avoided in arranging foundations for machinery or in laying subsoil piping.

The general practice now provides a sub-basement for the purposes of the plant, providing much more space than could be afforded nearer the street. Yet such are the demands of business that even sub-basement space is valuable, and cannot altogether be devoted to the engineer. Such sub-basements are also very difficult places to provide with air and light, for which a very early demand must be made, if they are to be secured. The hight generally is not less than 10 feet, which, however, is insufficient for water-tube boilers; therefore the fireroom is usually excavated to a further depth, exposing the bases of columns and frequently going below the water line.

The disposition of the main engines and pumps is chiefly decided by the position of the foundations of columns, and the necessity of access and repair. The arrangement of auxiliary pumps is such that they shall be so readily reached by the fireman that it shall be unnecessary for the engineer to stand by them at all times.

This also enables the engineer, at certain hours of light duty, to attend to the firing.

The relative position of the coal storage to the fireroom is of less consequence than its proportions. The fireman may easily attend to his own coal passing if provided with a track. But unless the coal storage is large, a coal trimmer must be kept to receive the daily supply. Trimming in the store costs, in certain buildings, 5 to 15 cents per ton. Such a large storage as the Bowling Green, which can contain 420 tons, has been found of advantage in reducing the price of fuel about ten cents per ton, as it is not required to be delivered at any particular hour.

A considerable variety and extent of labor is required in office buildings, and may be reduced by carefully planned arrangements and appliances.

The general superintendence is com-

monly delegated to a renting agent, who is paid by a percentage of 3 to 5 per cent. on the rentals received. The actual duty of superintendence then falls on an employee who has, generally, a number of such buildings in charge, which are therefore largely left to the mercy of the janitors. A better method is followed in some buildings by the addition of the duty to that of the chief engineer, when much closer supervision over details of operation is possible.

The rates of wages per week are as follows in an average sixteen-story building:

One janitor, without residence.	$15
One doorman, or hall porter...	$10 to 12
One car starter, with uniform..	12 to 14
Four to six elevator boys, with uniform	10 to 12
Three window cleaners.....	8 to 10
One toilet cleaner.....	8 to 10
Twenty to thirty scrubwomen (5 to 9 P. M., 6 to 9 A. M.).	6 to 8
One watchman.....	10

and the following in the engineering department:

One chief engineer.....	$25 to $31.50
One assistant engineer.....	20 to 22
One electric-elevator man...	20
One electrician.....	18 to 20
One night engineer.....	15
One leading fireman.....	16
One asst., or night fireman..	13 to 14
One coal passer and ashman.	12
One oiler.....	12

Commercial Review.

NEW YORK, SATURDAY EVENING, June 17, 1899.

MACHINISTS' SUPPLIES, ETC.

The inherent strength of demand for manufacturing supplies is evidenced by the tenacity with which business is holding on in spite of the advance of summer. Some tapering off is naturally to be expected at this time, and some there is in sundry quarters, but it is slight. It does not denote dulness, but a condition of activity only less than that of the spring. Manufacturers of supplies will probably not take it amiss if they have opportunity during the summer to catch up with their orders and accumulate stock for fall trade.

The advanced prices on many commodities do not frighten buyers out of the market, nor cause them to wait for a reaction. They know that they must have the goods and realize that they will have to give the money demanded. Indeed, one machinery and supply seller states that there is less haggling over prices than there used to be.

The Diamond Machine Company, Providence, R. I., has virtually passed into the control of the Builders' Iron Foundry, of Providence, through acquisition of stock in the former by officers of the latter.

The officers of the Diamond Machine Company are now as follows: Z. Chafee, president; J. A. Cross, treasurer; W. C. Buell, secretary; all of these gentlemen being connected with the Builders' Iron Foundry. It is announced that the Diamond Machine Company will continue to carry on business independently. There is some talk of an advance of prices of polishing and grinding machinery by the two companies.

In some quarters, though not in all, there has been a marked shortage of emery this season. A certain company was at one time 2,000 tons behindhand with orders. The importance of this amount will be appreciated, from the fact that the entire annual production in this country five years ago was not greatly in excess of 5,000 tons. The company referred to is understood now to be gaining on its orders. The prices of emery wheels have not risen, nor has there been any material change in those of emery.

Two emery-wheel dealers report better trade this month than in April or May. One of them has received a stock order from a European house for 500 or 600 wheels of 5 to 20 inches in size. The European dealer is accustomed to place a stock order with him every three months. The business of another emery-wheel company in the New York market, which is one of the most extensive sellers in this line of trade, is reported still very excellent, although slightly tempered by natural seasonable influences.

The L. S. Starrett Company has doubled its water-power rights at the dam where it takes power for its factory.

The File Manufacturers' Association of the United States promulgated, June 1, a new price list of files and rasps. This schedule applies generally to the leading brands. In general, it is higher than the old list. The discounts of the various makers are expected to be held about the same as formerly; consequently the adoption of the new list means an actual advance in the net price.

In a conversation yesterday with a machine-tool dealer in this city, who handles the goods of several companies, a representative of the "American Machinist" was asked if business was was not generally reported as improving over its condition a few weeks ago. The party asking the question found it so. Electrical manufacturers, rock-drill manufacturers, railroads and steamship companies were buying heavily, he noticed. Deliveries were growing harder and prices continued to advance. He alluded to a proposition under discussion for an important and concerted advance, by a number of companies making a particular line of tools, which might take place July 1. As the matter was undecided, he declined to enter into particulars. A few weeks ago a man came to this dealer and bought a large machine, but repudiated the contract and placed his order elsewhere. Later the buyer has returned in penitence, complaining that he cannot get the machine delivered within a reasonable time, and wanting to buy another one of this party from whom he had withdrawn the first order.

MISCELLANEOUS.

A local machinery and supply house has lately sold considerable gold mining apparatus destined for Honduras and Dutch Guiana.

The Ames Iron Works have received an order for a 350 horse-power automatic engine to go in the Fleischmann plant, being erected at Peekskill, N. Y. A General Electric dynamo will be used with the engine. The Ames Iron Works have recently sold five or six boilers to be shipped to Mexico. They report the stringency in boilers as increasing. Their price has lately been advanced anew, making about 33⅓ per cent. advance in all. Their factory is running day and night.

The electric motor business keeps such companies as the Sprague, the Bullock, the C & C, the Eddy, and the Crocker-Wheeler continually hustling, and the Westinghouse and General Electric Companies are now giving considerable attention to small motors for factory power distribution. Following are some memoranda of motor orders taken by the Westinghouse Electric & Manufacturing Company: A contract has been received from the Industrial Iron Works, Omaha, Neb., for electric motors. Bement, Miles & Co., Philadelphia, have ordered several 10 horse-power motors to operate overhead traveling cranes and other machinery. The Otis Elevator Company, Yonkers, N. Y., is taking a considerable number of electric motors to operate the new elevators which they are installing in New York City. The American Steel Foundry Company, St. Louis, Mo., are adding to their plant some 30 horse-power motors. The Pasedena Manufacturing Company, Pasadena, Cal., is adding to its factory several induction motors, which will be driven by power from the power house of the San Gabriel Electric Company. The Papana Chemical Company, Wilmington, Del., are installing several Westinghouse type "C" induction motors for driving machinery in their works.

The Richmond Locomotive Works, which have a contract for ten locomotives for a Swedish railroad, were this week making shipment, at Newport News, of a part of the order, to the extent of 32 carloads of machinery.

Apportionments of space at the Paris Exposition to tool builders have for the most part been made, and it is expected that in a few days the allotments will be definitely settled. As a rule the machines are to be motor driven, with the three-wire direct-current multiple-voltage system for distribution. Exhibitors may have their tools run by belts if they choose, but there will be no regular line shafting in the building.

CHICAGO MACHINERY MARKET.

For power transmission appliances Western trade was never better than now. Makers of shafting, pulleys, hangers, belting, and kindred lines have all the work they can do. Some are running overtime. It has become a common occurrence to turn business over to competing shops. Prices are advancing slowly, but without cessation, for which the rising values of the material are to a greater degree, perhaps, more accountable than the increased demand. The call for power transmission is especialy large from the South. Cotton mills, cotton-oil plants and saw mills are among the branches of industry in that locality that are insistent in the matter of machinery improvement. It is stated that some of the saw mills of the South are so crowded with business that they are compelled to decline additional trade. The sugar beet development in the West is another important factor to the present demand for machinery and power transmission. Quite a number of plants of this kind are in process of erection in Michigan, Kansas, Nebraska, California, Illinois and other Western States and are making heavy drafts upon the machinery trade. The amount of machinery in a sugar-producing plant is very large and makes great inroads upon the producing capacity of a shop.

In contrast with the above activity, the trade in machinists' supplies is tapering off towards the usual summer quiet. It is not quite so active as a month ago. There is a little letting down in energy among a fair proportion of the manufacturing plants. The bicycle trade is not taking supplies so freely. The agricultural implement men are reducing their requisitions to a noticeable but not as yet very decided extent. Accompanying this slowly decreasing trade is the readier response of the factories to the orders that are sent in. Chucks, drills, files and similar goods are in better supply. The excessive demand of a few months ago caught many of the manufacturers unprepared, but they have since more successfully met the enlarged conditions. Prices of all kinds of supplies are still tending upward. Material is advancing and with it labor.

The Chicago Belting Company has had an unusually large trade during the past month. Among the plants which it has just contracted to fit out with belting is a large cement works of Allentown, Pa., and a large saw mill at Lake Nebagamon, Wis.

The Armstrong Brothers Tool Company reports a continued active trade. It is doing an especially good business with the Armstrong drill and reamer holder and has just booked several Government orders.

CINCINNATI REPORT.

It may be excusable to preface a report on the machinery market by brief reference to a factor influential upon business in that, as well as in every other line—the agricultural situation. Grave fears are entertained as to the outcome of the year's crops. In some States not more than a third part crops is expected to be harvested. In others an almost complete failure is looked for. In this State (Ohio) anticipations are for half crops, while farther West, in Kansas and the Dakotas, the outlook is uncertain. As heavy crops of the last two years were extremely beneficial to the railroads and thus, indirectly, to machinery manufacturers, so now a reverse influence may be brought to bear upon the machinery market. Yet the industries of the country have gotten such a good start in all directions, and machine builders have so many sources of demand to depend upon, that they have no cause to be stampeded by a shortage in one season's crops.

The condition of the machine tool trade, in its general features, is not changing very much, but gives evidence of continued growth. May proved an exceedingly good month, in the amount done, and this month will probably exceed it. Some manufacturers still have more export trade than home trade, though with many the reverse is the case. The cost of raw and finished materials, but particularly the raw, has been increasing steadily. Where about a year ago No. 2 Foundry Southern iron was selling from $7 to $7.25 at furnace, it is now worth about double those figures, and other grades of iron have advanced in proportion. Some think this may tend ere long to check the demand and give furnace men a chance to catch up in filling the orders now on their books. Finished iron used in manufacturing has advanced some $17 a ton since January 1, or from $19 up to $36 a ton. The lower grades of finished steel have advanced some $20 per ton, and shafting $30 per ton. Manufacturers of machinery and machine tools are not as yet getting an advance in prices in proportion to the cost of materials.

Interviews among manufacturers furnish proof of the active condition of trade. The Sebastian Lathe Company still have a large run of orders, about 75 per cent. of their business being foreign. They have shipped one carload of lathes to China, and have other foreign orders for seven carloads.

The Wais & Roos Shear & Punch Company will erect a new building on Plum street, 90x90 feet, three stories high. They will put in new machinery, greatly adding to their present facilities.

Dreses, Mueller & Co. have added some $5,000 worth of new machine tools to their plant, and have made some large shipments to California.

Dietz, Schumacher & Boye have the walls of the addition to their new plant up, and the roof is being put on, and ere long will be equipped with large outfit of new machine tools.

DETROIT (MICH.) NOTES.

The Penberthy Injector Company has recently made a large extension in its facilities, putting in new machinery and to some extent remodeling its factory to enable it to cope with the large increase in the demand for its product. The factory force has been worked overtime for the past three months and an all-night force has been arranged for. By a recent decision the name "Penberthy" has been acknowledged the property of this company in reference to its injectors.

F. X. Rousseau reports an encouraging demand for his safety lift blocks, and is preparing to manufacture and dispose of a larger quantity this year. He may also undertake the manufacture of a machine-tool specialty, for which his shop is well suited.

Quotations.

NEW YORK, Monday, June 19.

Iron — American pig, tidewater delivery:—

Pennsylvania irons:	
No. 1 foundry	$18 00 @ 19 00
No. 2 foundry	17 50 @ 18 50
No. 2 plain	17 00 @ 17 50
Gray forge	16 50 @ 17 00
Alabama irons:	
No. 1 foundry	18 75 @ 19 25
No. 2 foundry	18 25 @ 18 75
No. 3 foundry	17 75 @ 18 25
No. 1 soft	18 75 @ 19 25
No. 2 soft	18 25 @ 18 75
Foundry forge	17 25 @ 17 75

An advance in the freight from Birmingham from $3.75 to $4.25 per ton is about to take effect, and this is allowed for in the quotations on Alabama irons.

Bar Iron—Base—Mill price for refined in carloads on dock, 1.83c., upward; from store, 2.10c., upward. Common from store, 2.00c.

Tool Steel — Base Sizes — Standard quality, 7 @ 8c.; extra grades, 12 @ 14c.; special grades, 16c., and upward.

Machinery Steel — Ordinary brands, from store, in small lots, base, 2.40c., upward.

Cold Rolled Steel Shafting—Base sizes, from store, in small lots, 3½c.

Copper—Carload lots, Lake Superior ingot, 17¾ @ 18c.; electrolytic, 17⅛ @ 17½c.; casting copper, 17 @ 17¼c.

Pig Lead—Carload lots, 4.45 @ 4.50c., f. o. b. New York.

Pig Tin—For 5 and 10 ton lots, 25¾ @ 25⅞c., f. o. b. New York.

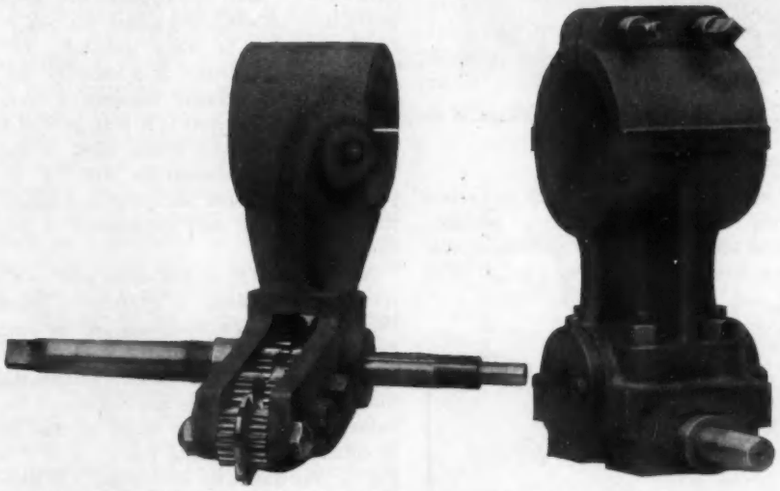
Spelter—Prime Western, in carload lots, 5⅞ @ 6c., New York delivery.

Antimony—In cask lots and over, Cookson's, 11c.; French, E. B., 10c.; Hallett's, 9⅞c.

Lard Oil—Prime city, ice pressed, 41 @ 43c. for the leading brand, in wholesale lots.

Gear Cutting Attachments for the Milling Machine.

The two half-tones herewith show a couple of attachments for any of the familiar types of milling machine; the first for cutting internal gears, and the second for rack cutting. They will be readily understood without explanation by those familiar with this line of work. In each case the main bracket slips on to the overhanging arm of the machine, the large hub being split for securely clamping. In each bracket also there is a spindle with the usual taper shank which fits into the milling machine spindle and is driven by it. In Fig. 2 this spindle is not shown, but the hole for it is seen. In Fig. 1 it will be seen that the axis of the cutter is parallel with that of the driving spindle, and the arm of the bracket simply gives a sufficient extension to carry the cutter through the gear, the cutter being driven by a small gear upon each side of it, and these



INTERNAL GEAR AND RACK-CUTTING ATTACHMENTS FOR MILLING MACHINE.

connected back to a gear upon the spindle by means of the two intermediate gears, as shown. The sleeve which carries the cutter, with the gear upon one side of the cutter are made of a single piece of steel, while the gear upon the other side of the cutter is, of course, removable for the purpose of putting the cutter on. The feather which drives the cutter also secures the removable gear. This gear is snugly fitted to the sleeve and the feather before the teeth are cut, and the teeth of both the gears are then cut together. The intermediate gears and their sleeves, as also the gear on the driving spindle, are each, of course, a single piece of steel. The internal gear to be cut with this device is usually a detachable ring, and must be chucked with an offset at least equal to one-half the diameter of the cutter to allow it to cut through the tooth.

In Fig. 2 the rack-cutting cutter revolves at right angles to the machine spindle, and it may be used on either end of the cutter spindle. There is a helical gear on the cutter spindle and also one on the driving spindle, each with 45-degree teeth. The outside diameter, of course, of the gear cannot be greater than the smaller diameter of the cutting teeth, but it is found to drive effectively, and of course also smoothly. With this device a rack may be cut at a single setting as long as the lengthwise travel of the table, and by successive shiftings it may be cut of any length required. These attachments were made by The Arthur Company, 188-190 Front street, New York.

Machinists in the Navy.

The examinations which are now being conducted preliminary to the promotion of some of the machinists of the navy to the coveted grade of warrant machinist serve to attract the attention of many of the young mechanics of the country to the navy as a career. For at last the naval machinist has a career. In the past it has been practically impossible to secure and retain for the naval service men of the right character and ability. Men of the right stamp have drifted into the service and some have remained for more than one cruise, but the greater their ability the more clearly was it apparent to them that for duty well and faithfully done they would have to look for their reward in a country somewhat remote from this planet. The best prospect that could be held out to them was a dreary existence in a naval home after a certain period of service.

Of course not all the young men who enter the navy in the various ratings of machinist—second class, first class, or chief—can hope to reach the warrant rank. In fact many recruits will not care to make more than one cruise. Some will find the duties and restrictions too onerous; others, preferring the joys of domesticity, will be content with the experiences of a single cruise and will then join their brother machinists ashore. Others will fail to reach the high all-around standard of attainment that the Navy Department wishes to establish for the highest grade of machinist, and these must remain in one of the inferior ratings.

I would not hesitate to advise any young machinist to make a cruise in the navy. There is no great danger of injury to his health, because only the physically sound are permitted to enlist, and the hygienic conditions on board modern ships are very carefully looked after. It is found that persons of good constitutions and temperate habits can by exercising proper care withstand the climatic conditions of the tropics very successfully. From the earliest times travel has been considered one of the most potent factors in education, and wealthy men have usually permitted their sons to enjoy a period of travel abroad or at home before requiring them to adopt a profession or other calling. The navy, then, for the young intelligent mechanic, ambitious to see something of the world, to expand his mind and to store his memory with experiences both useful and pleasant, is peculiarly inviting. Much of the work on board ship is difficult; the situations are trying and uncomfortable; there is much emergency work; and above all the discipline is strict. But discipline has never hurt anybody, and our young machinist, whether he remain in the service or not, will look back upon his first cruise in the United States navy with many a pleasurable thought. Should he decide to spend the balance of his career in shore pursuits, surely the unique and varied experiences of his ship life will not have been without value in his training. As a man of expedients his services will be of increased value to his shore employers; and possibly his observing mind may have grasped a hint or two, while observing new lands for the first time, that may lead to some successful commercial enterprise. Should war break out between the United States and a foreign power he will be able to offer to his country something more than money or other material wealth—the services of a trained man.

The warrant machinist is an officer, and as such he enjoys many of the privileges and comforts that pertain to commissioned rank. His cruises are alternated with periods of shore duty, and in his old age he retires from active service with three-fourths of his highest pay and the rank of a commissioned officer.

THOMAS W. KINKAID,
P. A. Engineer, U. S. N.
U. S. Naval Academy.

It is stated that certain additional street railways which were to be laid in Paris, and which were to be completed before the great Exhibition of 1900, have been given up on account of the impossibility of getting the 40,000 tons of rails required. They were not obtainable in either France, Belgium or Germany.

Some Points in Spiral and Worm Gears Learned in a Machine Shop —A Worm-Wheel Hob—Why a Hob Failed—The Nature of Worm Thread Contact—I.

BY OSCAR J. BEALE.

In the works of the Brown & Sharpe Manufacturing Company a pair of gears was wanted of the spiral or screw type, and it was thought better to make the

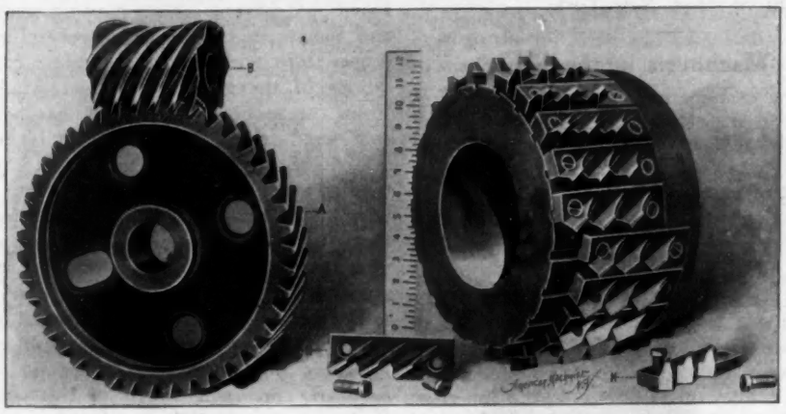


FIG. 1. PECULIAR WORM GEAR. *A* WORM, *B* WORM GEAR.

large gear, or member, as a worm and the small member as a worm-wheel.

Fig. 1 shows the worm and wheel in mesh; *A* is the worm and *B* is the worm-wheel. The large member, or the worm *A*, has 43 threads; the lead of the worm is 60.3 inches, and the thread pitch, or the axial pitch, is 1.4 inch. The small member, or the worm-wheel *B*, has 7 teeth, and the circular pitch of the wheel is, of course, the same as the thread pitch of the worm, 1.4 inch.

Fig. 2 is an axial section of the worm threads. The threads incline 57 degrees from the plane perpendicular to the axis, which is so great that, while the axial thickness of the thread at the pitch line is 7-10 inch, the actual or the normal thickness is not quite 4-10 inch. In Fig. 3 the line *C D* shows the inclination of the threads; *C E* is the axial pitch, and *F G* the actual or normal pitch.

In cases where the inclination of the thread is more than 15 degrees, that is, in cases where the normal pitch is less than .96 of the axial pitch, it is well to have the depth and the addendum correspond to the normal pitch. Fig. 4 is a normal section of the thread, the depth being the same as a gear tooth of equal pitch, which makes the thread look shallow and thick when seen in the axial section, Fig. 2.

The word module is a convenient term to designate the distance obtained by dividing the diameter of a pitch circle into as many parts as a wheel has teeth. There are as many modules in the diameter of a pitch circle as there are teeth in the complete wheel. In spur wheels the practice of most mechanics is to have the addendum, or face of the teeth, equal in hight to the module, but in screw gears where the normal pitch is less than .96 of the circular pitch it is well to have the addendum proportionally less than the module. In Fig. 1 the module of *B* is .446 inch at the throat, while the addendum of the teeth is only .244 inch.

The worm-wheel B, Fig. 1, was hobbed, or cut, with the hob shown in Fig. 5.

The foregoing examples in connection

FIG. 5. HOB USED FOR CUTTING WHEEL *B* OF FIG. 1.

with worm gearing came up in actual practice. While they do not, perhaps, illustrate any principles in mechanism that are not already well known, yet I think

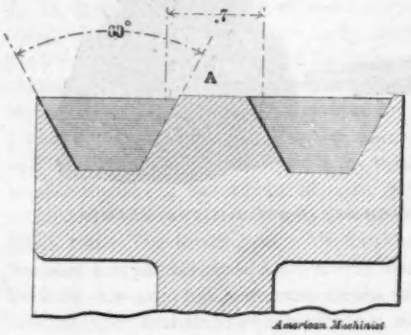


Fig. 2

AXIAL SECTION OF WORM THREADS.

that they have some points that may be new and of general interest. The worm has more than six times as many threads as the worm-wheel; the pitch diameter of the worm is four times that of the wheel; the wheel is the driver. The hob is made up of a cast iron body, upon which are fastened lags that are arranged in steps in order to have the lags alike for convenience in making the lags. Once a large hob was made that did not work, because the cutting edges of the hob teeth did not trim the tops of the worm-wheel teeth narrow enough to clear the backs of the hob teeth, which jammed so hard that the machine could not go. This jamming of the backs of the hob teeth upon the tops of the worm-wheel teeth was owing in part to incorrect spacing of the lags *H H*, Fig. 5, which will be explained, the Brown & Sharpe Manufacturing Company having kindly given me the privilege of using these examples for publication.

The exact nature of the contact between a worm thread and a worm-wheel tooth does not seem to have been definitely determined. There is a question as to whether the contact is along a line, or on a single point at any instant. In the "American Machinist" for May 19, 1888, Mr. George B. Grant treats upon this question, and he recognizes the usefulness of models as a help in solving it. I have in mind two or three models which the Brown & Sharpe Manufacturing Company will make for me to study. With these I hope to make some advance toward a solution. When spiral gears are new there are undoubtedly only point contacts between their teeth.

The points referred to in this article all relate to such spiral and worm gears as connect shafts that run at right angles to each other. Both spiral gears and worm gears may be classified under the general term of helical or screw gearing. As a matter of convenience in a machine shop a distinction is made between a spiral gear and a worm gear. It may be well to define some of the terms used in this article. These definitions are for our present purpose and are somewhat special, though they are well established in shop use.

A spiral gear is such a screw gear as has its teeth cut along a cylindrical blank, the form and the thickness of the teeth being determined upon the basis of the shortest line upon the pitch cylinder that can be drawn between the centers of two consecutive teeth. The length of this line is equal to the normal pitch, as at *F G*, Fig. 3. As stated by Mr. Grant, it is probably not mathematically exact to form the teeth upon the basis of this line, but it is an approximation that is accurate enough practically. Spiral gears are usually cut with ordinary gear cutters. According to this definition a member that has only one

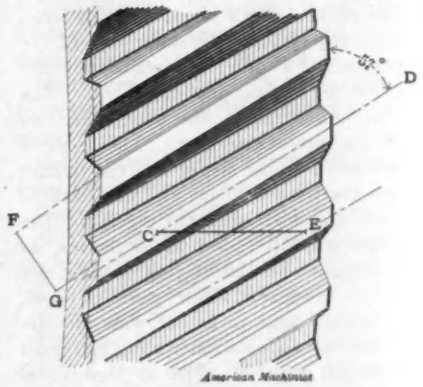


Fig. 3

AXIAL AND NORMAL PITCH.

tooth may be cut with a gear cutter and be called a spiral gear. Such a gear is illustrated in the "American Machinist" for

October 27, 1898. A spiral gear could be cut with a lathe tool.

A worm is a screw whose threads have the same outline, upon an axial section, as the teeth of a rack, the purpose of a worm being to mesh with a gear. A worm gear meshes with a worm. The action of a worm meshing with a worm

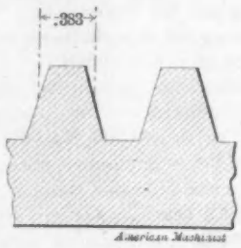


Fig. 4

NORMAL SECTION OF WORM THREADS.

gear is analogous to that of a rack with a spur gear, as stated by Professor Willis in his "Principles of Mechanism." In most worms the outlines of the threads upon the axial section, have straight sides, as in Fig. 2, which correspond to the sides of rack teeth in the involute system of gearing. Worms are usually threaded in a lathe. This well-known definition covers the case of Fig. 1. The worm *A* was threaded in a milling machine with a cutter, but its character as a worm is the same as if threaded in a lathe. Worm gears are often called worm-wheels, but a spiral gear is not called a spiral-wheel.

The angle of the teeth of a spiral gear is measured from a line parallel to the axis of the gear; the angle of a worm thread is measured from a plane perpendicular to the axis of the worm. In a pair of spiral gears both members can be adjusted or moved endways of the shaft. In a worm and worm-wheel a curved hollow-faced member cannot be moved endways or in the direction of its axis after being once set correctly in mesh.

Fig. 5 is a hob made up of a cast iron body, into which are fastened lags *H H*. Two of these lags are shown detached. The lags were threaded in axial section like *A*, Fig. 2. The resulting teeth were trimmed and backed off, as in the detached lag on the left. The numbers in the scale are for inches.

(*Concluded next week.*)

The Cyclostat.

The neat and ingenious instrument shown in the accompanying cuts has been devised by Dr. Charles A. Perkins, of the University of Tennessee, and is called by him the "Cyclostat." It is for continuously viewing a rotary object. Many instruments for this purpose have been made, but mostly on the principle of the thaumotrope, in which a succession of instantaneous views produces the impression of a continuous image, but with a much diminished illumination. The present instrument possesses the great advantage of giving a clear, continuous and fully illuminated view of the object.

The instrument is shown in section in Fig. 1, and in position for use in Fig. 2. The object is viewed by looking through the large revolving tube *A*, Fig. 1, either in the direction of the arrow or the reverse way. In this tube is placed transversely the right-angled prism *B*, with its long face parallel to the axis of the tube. Objects seen through this prism are seen reversed, and, if rotating, the direction of the rotation is reversed, and at whatever speed the tube and prism are rotated the image of the object viewed will rotate twice as fast. If the tube and prism are rotated in the same direction as the object, and at one-half the speed, the object appears at rest. The shaft *C*, then, is connected to the rotating object by the flexible shaft as shown, or by any other suitable means. The pinion *D* on this shaft has one-half as many teeth as the gear *E* on the rotating tube. This comprises the entire mechanism.

The instrument was first designed for reading the angular displacement of a pulley mounted loosely on a shaft to which it was connected by a spring. This arrangement forms a transmission dynamometer free from cams, levers, or other devices for indicating the torque. It is also of use for many purposes, such as the examination of a fly-wheel governor under changes of load, or, with the cyclostat driven by an independent uniform motor, the regulation of an engine under sudden changes of load can be perfectly determined. It may also be used as a synchronizer for alternators. Driven from one alternator by mechanical connection, it will cause the second machine to appear at rest when the two have the same speed. In the repair shop it can be used to see which bar of the commutator is sparking.

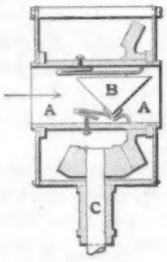


Fig. 1

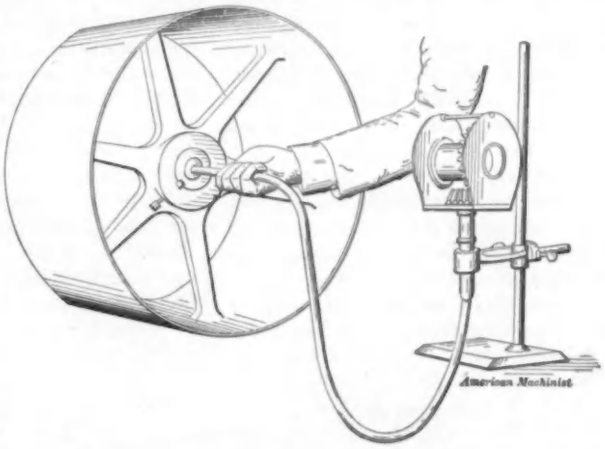


Fig. 2

THE CYCLOSTAT.

"There is much more credit due to a man who takes good advice than to the person who gives it."—M. N. Forney.

Switzerland's Machinery Trade and American Machine Tools in Switzerland.

In 1897, the last year for which comparable figures are available, Switzerland's exports of machinery amounted in value to about $6,800,000. During the same year the exports of machinery from the United States were valued at $34,600,000. When it is considered that Switzerland is a country of only 16,000 square miles—about one-third of the area of our State of New York—that nearly one-third of this small territory is barren, and that every pound of coal and every pound of iron has to be imported, it will be readily understood to what a high degree of efficiency Swiss engineers have brought their works. In spite of the fact that Switzerland is surrounded by such highly developed industrial States as are Germany, Belgium, France, England, countries in which the two most essential raw materials for a metallurgical industry—coal and iron—are plentiful, Swiss machinery has found its way into the very heart of these countries, and is able to compete with them in any market of the world. Thus, in 1897 Switzerland exported machinery to the following countries, viz.:

(1) Germany.—Steam boilers, $30,600; electric machinery, $280,200; agricultural machinery, $19,820; milling machinery, $91,600; sewing machinery, $4,600; textile machinery, $397,200; machine tools, $14,100; other machinery, $751,600; parts of machinery, $30,200. Total, $1,619,920.

During the same year the imports of German machinery into Switzerland amounted to the value of $4,459,200.

(2) Austria Hungary.—Exports of machinery from Switzerland, $547,000; imports from Austria Hungary, $93,420.

(3) France.—Exports from Switzerland, $1,040,000; imports from France, $652,000.

(4) Belgium.—Exports from Switzer-

land, $98,600; imports from Belgium, $255,800.

(5) Great Britain.—Exports from Switzerland, $244,600; imports from Great Britain, $682,000.

Other principal countries to which Swiss-made machinery was exported were: Russia, $1,476,100; Italy, $829,200; Spain, $488,820; Japan and China, $179,600; Argentina, Uruguay and Paraguay, $96,800; United States, $79,800; Turkey in Europe, $49,400; Turkey in Asia, $4,800; Sweden and Norway, $55,400; Brazil, $52,000; Chile and Peru, $36,400; Mexico and Central America, $27,200; Bulgaria, Roumania and Servia, $26,700.

From these figures it will be seen that there is scarcely an inhabited spot in either hemisphere where Swiss machinery cannot be found; and all this without navy or merchant marine, with scarcely any consular service, and without any export associations. The Swiss machinery export trade is continually growing. During the first six months of 1898 the exports amounted to the value of $3,695,600, as compared with $3,407,000 during the same period of the preceding year.

As to the principal items in the Swiss machinery export trade, the following may be mentioned. During the year 1897 there was exported: Electric machinery, $1,764,000; textile machinery, $1,679,600; flour mill machinery, $627,000; boilers, $151,200; locomotives, $147,000; machine tools, $87,100.

Thus it will be noticed that the most prominent items are composed of electrical, textile and flour mill machinery. In these lines the Swiss engineering works turn out first-class work in every respect. Large establishments with the most improved modern equipments are engaged in the manufacture of electric machinery.

The Compagnie de l'Industrie Electrique, at Geneva, the only firm building dynamos after the "Thury" system, is doing a splendid business. Everywhere this firm sent their machines for exhibition they were rewarded; thus at Zurich, 1883; Turin, 1887; Havre, 1887; Brussels, 1888; and at the last Paris Exposition, 1889, they got two gold medals.

Well known, also, are the large electrical shops of the Oerlikon Company, near Zurich, and those of the Société Suisse pour la Construction d'Accumulateurs Electriques, at Marly-le-Grand, near Freiburg. Cables of the first class are turned out by the Société d'Exploitation des Cables Electriques, at Cortaillod.

It may not be exaggerating to say that the wonderful development of this branch of Swiss engineering, electrical, can to a large extent be traced to the natural conditions of the country. Its many and powerful waterfalls offer the best means for electrical plants. At the same time, this abundance of water (industrial water we may call it) has given rise to another manufacture in which the Swiss engineers excel, hydraulic turbines and water-wheels. Thus the world-renowned firm of Piccard & Pictet (formerly Faesch & Piccard), of Geneva, have supplied the 5,000 horse-power turbines for the Niagara Company, and water-wheels made by this firm are to be found all over the world. Another well-known establishment making the same specialties is the stock company under the title of Atéliers de Construction Méchaniques de Vevey, at Vevey.

The exports of steam engines also are very considerable. In the manufacture of the latter the world-renowned firm of Sulzer Bros., of Winterthur, especially excels. Their engines enjoy the very best reputation all over the European continent and in many transoceanic countries.

Another important engineering works at Winterthur is the Schweizerische Maschinen und Locomotiv Fabrik, which are especially engaged in the manufacture of locomotives.

That such a highly developed industrial country creates a market for machine tools is a matter of course, and in this very same article American manufacturers should by all means be able to make a better showing.

In 1897 the imports of machine tools into Switzerland, according to the official Swiss statistical returns, were as follows: From Germany, $182,200; France, $34,640; United States, $19,800; England, $9,750; Belgium, $2,440; Austria, $1,370; Italy, $480; Sweden, $92. Total, $250,772, as against $210,200 in 1896.

These figures show that Germany takes the lead in this trade, followed next by France, while the third place is occupied by the United States. There is, however, every reason to suppose that by more energetic and systematic efforts on the part of our manufacturers a far larger share of this trade could easily be secured for our country. G.

Cylinder Boring Machines.

The period in which engine and pump builders could afford to bore cylinders on lathes has long passed, and in these times such work is done almost exclusively on special boring machines designed and built for the purpose.

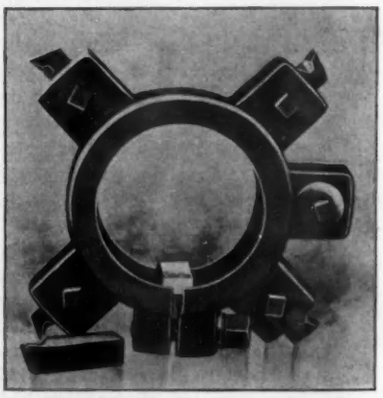
Our illustrations are of two machines of this class which represent a line of similar machines of various sizes and designs built by the Meadville Vise Company, Meadville, Pa.

The first of these machines, called their No. 2, is designed for cylinders up to 48 inches long, with flanges up to 40 inches diameter, and it will bore and face both ends at the same time.

The distinctive features of the machine are well shown in the engraving. The pedestals which support the bar are bored with bearings 6¾x11¼ inches for sleeves, which turn with the bar and afford bearings for it 20 and 25½ inches long, respectively. On the end of these sleeves are arms which carry the facing tool slides which are moved by the usual star-feeds. The bar is driven by Albro worm gearing, giving a ratio of 55 to 1; both worm and gear being incased in a single casting and arranged to run in a bath of oil. The bearings for the worm-shaft are 2 3-16 inches diameter and run in bronze bushings 6 and 8½ inches long. There is also a bearing for this shaft outside of the cone pulley in a floor-stand.

The boring bar is 5 inches diameter, made of hammered steel of 25 to 30 points carbon. The sleeves are lapped out after boring, and are ground externally, the bearings in the pedestals being scraped to fit them. All bearings are cast iron fitted in this way, or are bronze or steel. There are four rates of feed, from 1-16 to ½ inch per turn, and the bar can be rapidly withdrawn across the open space to permit the work to be put in or taken out. The bed of this machine is 10 feet 6 inches long, 26 inches wide, 19 inches deep.

The second engraving is of a similar machine, but somewhat larger, and with a smaller machine fitted to its bed at right angles for boring pillow blocks in beds of large engines, where the larger bar is used for facing the end of the bed, boring stuffing-box holes, guides, etc., the bed being placed upside down upon the machine for this purpose. If desired, a fixture may be used for locating and holding the work by previously planed surfaces.



BORING HEAD FOR CYLINDER BORING MACHINE.

The form of head used upon the bar is shown in Fig. 3. Four regular boring tools are employed, and an extra pocket is provided for a tool for boring the counterbore.

The Premium Plan Criticised.

BY F. A. HALSEY.

The "Engineering Magazine" for June contains an article on "Methods of Remunerating Labor," by P. J. Darlington, in which the piece-work, piece-rate (Taylor system) and premium plans are discussed at some length. While these plans are compared and contrasted from various points of view, nevertheless, when the amount of space given to it is considered,

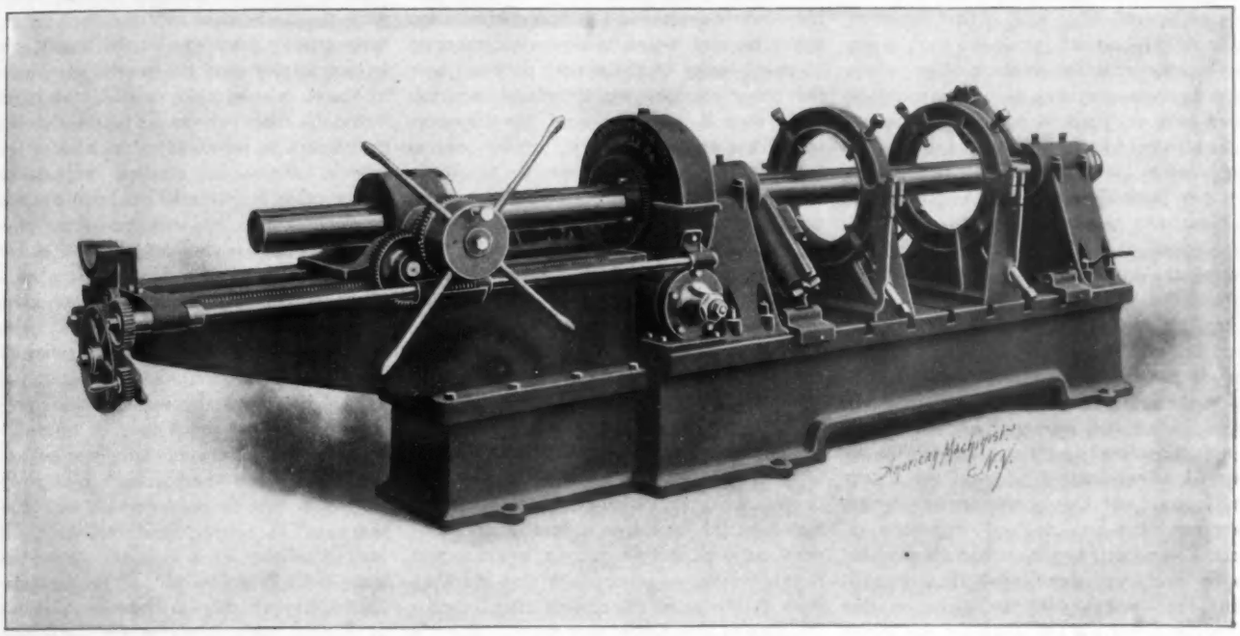
it is impossible to consider the article otherwise than, primarily, a criticism of the premium system, and as such a reply to it seems to be called for.

In this reply several quotations from the article will be necessary; but the fact that some paragraphs, and in some cases inconsistent paragraphs, which call for consideration together are widely separated, will make it advisable to group them in a different order from the one in which they appear.

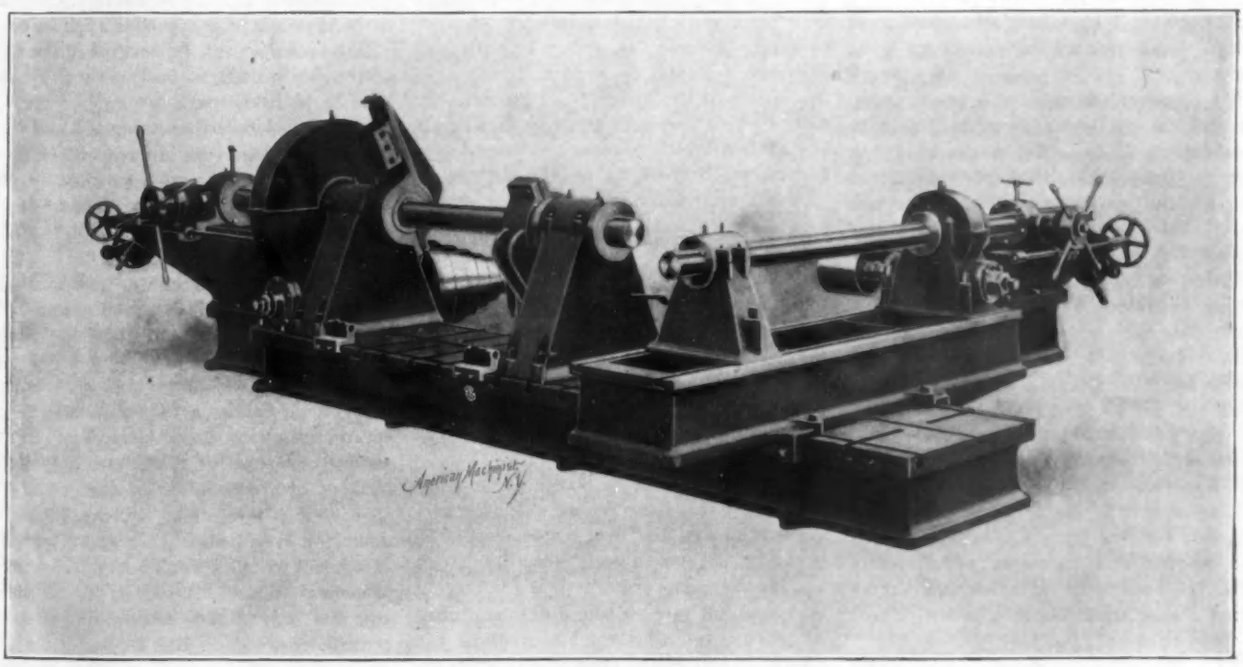
The first criticism reads:

"In the premium system there is no intermediate incentive until the worker has reached the old day-work limit (a low limit) of speed of production. As long as he refuses to pass that limit, either through discouragement, inability or laziness, he is working on day pay, and it makes no difference in his pay how little he produces. . . . It is a system of rewards without penalties, which is the basis of its only possible claim to favor with the workers, and is one cause of its weakness."

This is purely an academic objection. The difficulty of "soldiering" has never arisen in the application of the system with a single exception, where the workmen *en masse* refused to increase their output under it for fear of future cuts, in which, as in many other cases, they simply confounded it with piece work. In the main table published in the article of the March 9 issue, there are two cases in forty in which the time limit was not reached under the premium plan, the excess of time over the limit being 8 and 12 per cent., respectively. This is unexplained, but it may have been due to any of a dozen causes outside of the system of payment.



CYLINDER BORING MACHINE.



CYLINDER AND MAIN BEARING BORING MACHINE.

One case is known in which the attempt to graft on a penalty attachment to the premium system led to a strike; and while a little thing like that would not be expected to disturb an academician, it will appear as objectionable to most others.

"We will now assume," says the author, "that, through additional skill of the worker, the speed of production has been increased beyond what was at first assumed to be the highest attainable. . . . It is now evident that the wages cost per piece on the premium system is less than on the other two, and this is one of the advantages claimed by the inventor of the premium system, that it reduces the wages cost per piece in a uniform and progressive manner, with increase of speed of production, and without the necessity of cutting the rates and so discouraging the worker."

Exactly. It is the uniform experience that, under a suitable system of rewards that do not sooner or later turn into penalties, the production usually does increase beyond what was thought possible. This is a fundamental fact that can neither be ignored nor relegated to a minor place, and it was just this condition which the premium plan was devised primarily to meet. To admit, as the author does in the above quotation, that under these conditions the "wages cost per piece on the premium system is less than on the other two," is really to endorse it; and to those who appreciate the great preponderance of work of which this is true, the author's statements will be taken as an endorsement. Next appears the contrasted condition:

"If, however, the speed of production for any reason goes back from the original maximum, . . . the wages cost per piece is least with the piece-rate system and greatest with the premium system."

The academician again. There is no such going back.

Referring to piece work, which the author advocates, he says:

"It does not (without cutting the rates) reduce the wages cost per piece progressively, but it does rapidly reduce the equipment cost per piece or increase the amount of work produced by a given worker, machine or floor space.

"In work of such a nature or under such management that the speed of production depends entirely upon increasing skill of the worker and increases very rapidly with his experience or effort, there may come a time when his rate of wages will become altogether too high."

This, the second quotation above, and a third equally cursory remark are all the author has to say about rate-cutting under piece work. He does not seem to know that this leads to systematic "soldiering" under that system. He talks seriously of the great "incentive" offered the workman by that system because of the high earnings promised, but does not seem to know that the effect of cutting the rates whenever those earnings are reached is to neutralize the incentive and leave none whatever. He condemns the premium system because it provides no penalty for doing poorly, and endorses a system which introduces a penalty for doing well, for this is what a cut in the rates amounts to, as it compels the workman to work harder than before for the old income. He seems never to have heard of workmen learning of this penalty in the course of time, and thereafter making no effort to increase their output, but prates of the superior incentive of piece work, under which large earnings are prevented by rate-cutting, over the incentive of the premium plan, which sets no limit to a man's earnings except that set by his own capacity to produce. All experience with piece work shows that as a result of the large apparent incentive offered at the start, a large increase of output and wages results with a cut in the rates immediately on its heels. This may happen more than once, but eventually the workmen learn the game and stop further effort. Thereafter the piece-work system offers no incentive whatever, whereas with the premium plan the incentive is continuous. Indeed, so well known among workingmen is this feature of piece work that the wise ones refuse to increase their efforts when the plan is first introduced beyond what is necessary to bring their earnings up to the old day-wages rate, or perhaps a little above it. It is this uniform experience with piece work which forms the greatest existing obstacle to progress with the premium system. So well understood is the falsity of the promises of piece work, that workingmen have come to look upon any system which promises increased pay for increased work as equally dishonest. The author's blindness to the real workings of piece work is shown by the following quotation:

"The premium system has a less intense action even than the piece-work system, and is at the opposite extreme from the piece-rate system. The incentive is so slight that it cannot bring about the increased speed of production so quickly, or as great a final speed as the other systems."

All of which shows blindness to what constitutes real incentive as well as ignorance of one of the first principles of the premium system, namely, that by which the incentive is varied at will by varying the premium rate to suit different classes of work. Ignoring for the moment the effects of cuts in the rates, the inflexibility of piece work is alone enough to condemn it. In its usual form it offers the same incentive for cases where increased production calls for nothing more than an increase of speeds and feeds, with such economy of time as may result from grinding tools while the machine is at work instead of at rest, that it does for cases where every piece put out calls for so much toil and sweat. Our article of March 9 distinctly points out the advisability of adjusting the premium to suit the laborious nature of the work in hand. For cases, in which laborious work and high equipment cost are combined, and in which the largest output is the cheapest output, almost regardless of the wages paid, it may be wise to make the premium rate equal or even exceed the wages' rate. In the former case the results are similar to those of the piece work, and in the latter, to those of the Taylor differential piece-work or piece-rate plan, as Mr. Darlington calls it, but without the penalties or the other features which form the basis of workingmen's objections to those plans. Ignoring again the effects of rate cutting, the economic question is not which system offers the greatest incentive, but which offers the right incentive, i. e., which offers for increased production what that increase is worth? Too little may be offered, in which the increase will not be obtained; or too much may be offered, in which case the excess is simply a gift, and the flexibility of the premium plan in this respect is one of its commanding advantages. There are occasional cases described above in which the piece-work and piece-rate plans are economically sound, though they are always objectionable from the human nature standpoint. The premium plan is, however, equally applicable to all cases, while the others are not, and it is thus of relatively universal, while they are of but partial application.

The author seems, however, to have forgotten his words as last quoted by the time he had written a few more pages of manuscript, for further along we find:

"This reduction of intensity appears to the writer the only good purpose of the premium system, and even that is desirable only where low wages cost is more important than low equipment cost."

It is not easy to discuss a question with an author who thus blows hot and cold with the same breath. Taken by itself this last passage is a pretty good endorsement of the premium plan, but coming after much criticism of the supposed inferior incentive, it is simply an inconsistency to refer to it as "the only good purpose of the premium system."

However, the basing of the incentive upon the importance of wages cost and equipment cost is fundamentally wrong. Maximum output is wanted in all cases, and the only factor determining the incentive required is the character of the work from the workman's standpoint—that is, the degree of exertion involved in increasing the output.

When discussing the piece-work and piece-rate systems our author admits that:

"The fundamental requirement of both is the knowledge beforehand of what length of time a given operation should take."

This is exactly the main reason why

both are so unsatisfactory. It is very easy to talk glibly of fixing maximum rates of production beforehand, but we have met very few mechanics who believe it can be done. Piece work may deceive a superintendent into believing he has reached a maximum through the stoppage of progress, but in five cases out of six this is due to the fact that the men have learned their piece work lesson and have stopped making further efforts. The well-informed in these matters know that under proper conditions increase of output is continuous, without apparent limit. The impossible of last year is the accomplished fact of this, and the impossible of the present will be the fact of the future.

Another point criticised is:

"It [the premium system] starts upon the basis of day work management and increases the speed of production by offering premiums to the workers to induce them to show at what rate they can produce the work, instead of starting with the demand that the ultimate speed shall be attained."

Exactly. It leads instead of drives, and it has no greater merit than this.

After all this condemnation of the premium system we find this suggestion:

"Even under such conditions, can not better results be obtained more easily by a reduced piece-work system, as follows? Place a piece-work price upon the job subject to the limitation that beyond a definite rate per hour made (fixed for that class of work), the saving in wages cost shall be divided between the works and the worker. This would be accomplished in practice by issuing an ordinary piece-work ticket stamped across its face, 'reduced after —— cents per hour.' "*

This is a queer conclusion to an article which condemns the premium plan in almost every page, being, as it is, simply a clumsy attempt to accomplish the results of the premium plan by modified piece work. The clause "the saving in wages cost shall be divided between the works and the worker," simply appropriates the foundation feature of the premium system and discredits all the arguments brought against it. This plan involves the same reduced incentive which the author condemns in connection with the premium plan. Its only advantage (?) is that it reduces pay if the time limit is not met, which has already been shown to be unnecessary, and it is still piece work, because it names a piece price, and one shop is known in which precisely this system has led to a long and expensive strike. In other words, each of the author's suggestions—a penalty for not reaching the standard output, and a reduced rate per piece as production increases—has led to one strike each—an efficiency as strike-producers of 100 per cent., so far as the information at hand goes.

* A typographical error obscures the meaning of this paragraph, as printed in the "Engineering Magazine." At our request the editor of the magazine has supplied the correct reading, which is given above.

As a net result, the author of this article has at the end three systems, the piece-work, piece-rate and reduced piece-work systems, each of which he favors according as the relative importance of wages cost and equipment cost varies. As has been shown, the premium system is applicable to all variations of these conditions, and hence to all fields to which these systems are adapted. Inasmuch as these variations of conditions occur in nearly all large works, the autnor's alternative to the premium system is the use, side by side, of three systems, or if any days work is done, of four, the beauty and simplicity of which arrangement do not need to be pointed out.

Again we read:

"The condemnation of piece work in this connection has in every case been founded upon the assumption that piece-work prices are necessarily the result of a guess to start with and continual cutting of the rates without the use of tact or common sense."

Piece-work prices are made up from the records of previous experience, and always must be. We believe no shop ever introduced piece work, basing the piece prices on previous days-work results, as must be done, without finding it necessary to cut them sooner or later. "Tact" in cutting these rates may sugar-coat the pill, but it will not change the ultimate effect.

Toward the end our author asks "whether the premium system in itself is not a make-shift, necessitating greater complication, expense of handling and difficulty of installing, than the piece-work system, and very limited in the variety of work to which it can be applied profitably."

So far as complication and expense are concerned, some articles now in preparation will show how formidable the system is from this point of view. It may be said here that, recognizing the fact that in most machine shops a good deal of days work must be done in any event, the premium system involves less complication in its administration than any other whatever. A comparison of this feature between the premium plan and the nondescript suggested above, would be interesting. So far as the comparative difficulty of installing the premium and piece-work plans is concerned, the rooted objections of workingmen to the latter and the repeated strikes against it will answer the question. So far as the variety of work to which these systems are adapted is concerned, the premium plan applies perfectly to all that piece work does imperfectly, and in addition to a great field to which piece work does not apply at all, namely, that class of work which, while a regular article of manufacture, is yet not made on a sufficiently organized basis to justify the application of piece prices to the individual parts. For such work the premium offer is based on the entire time necessary to make the whole machine, and the premium earned is then divided among the men doing the work in proportion to their wages or time on the work.

All the weak points and inconsistencies of the argument have not been pointed out, but at the end is this paragraph:

"As to the published results attained in various systems, it should be remembered that a new and reduced cost over an old day-work cost, is of very little meaning. Almost any system will give better results than a total lack of system, as in day work. The improvement shown may mean a good system or a previous very poor day-work management."

This can only be regarded as a fling at the works which furnished the data published in our article of March 9—a fling which the author would be glad to withdraw could the name of those works be published.

In conclusion it should be remembered that whatever has been published in these columns regarding the working of the premium plan has been the outgrowth of experience with it. Few will agree with the author of the article here answered, that such experience has "very little meaning," but on the contrary, most readers will consider it a more than sufficient answer to all the *a priori* closet arguments that can be put in words. In this connection it will not be forgotten that in one of the shops using the premium plan (the Newton Machine Tool Works) that plan was adopted after years of experience with piece work, and is considered far superior to it. The fundamental fallacy of Mr. Darlington's argument is that he considers the incentive a mere matter of arithmetic, regardless of the effects of rate cutting, which is inherent in the piece-work system.

Machine Tools—IX.

BY JOHN RICHARDS.

TANGENT WHEEL FEED GEARING.

The advancement of tools, or material operated upon (in this country called "feeding"), is a function present in some form in all kinds of machine tools, and the means of doing it constitute a class of devices that may be considered separately. Feed motions are commonly performed by screws, which are the most simple of all means for reducing the rate of motion and at the same time producing rectilinear movement, but are liable to unequal wear, and have the fault of starting only at intervals of their pitch when engaged by fixed nuts. This, with some other reasons, has led to various devices that have to a considerable extent displaced feeding screws, especially in American practice.

One of the earliest and most ingenious feeding motions for spindles is shown in Fig. 73, and was applied by Whitworth to his drilling machines more than forty

years ago. The spindle *A* is a screw into which the tangent wheels *B* mesh at each side. The rotation of these wheels is resisted by the friction clutch *C*, operated by a screw and hand wheel *E*, as shown. Any resistance to the rotation of the tangent wheels, which act as a nut, is imparted to the spindle, pressing it downward. The spindle bearings are not shown.

This was not, however, the only function of this gearing. The spindles were over-counter-weighted, so that as soon as the clutch was loosened the spindle at once rose to the top of its stroke or to some point determined by a stop collar *D*, and when it was to be again forced downward by the clutch it was moved rapidly until the drill came in contact with the work, thus forming an automatic quick movement; all motions each way being controlled by the hand wheel *E*.

This was an ideal motion in theory, but its non-survival shows that it failed to meet the requirements of practical use.

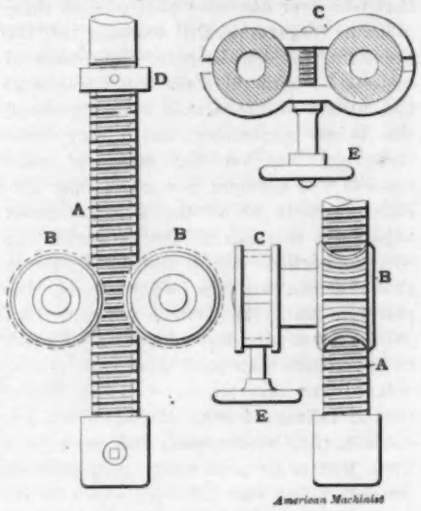


Fig. 73
FEED GEAR FOR DRILLING MACHINE.

There are, however, other adaptations of this gearing that were no doubt neglected because of failure or disuse in drilling machines. I have applied the same manner of operating in various ways and found it successful. On lathes for example, where it performed several functions usually accomplished by separate gearing. Fig. 74 will illustrate such an application to engine lathes. *A* is the carriage apron, and *B* tangent wheels, of which there may be two, four or six, four being the common number for small lathes of less than 24 inches swing. The tangent wheels were inside the apron, all meshing into the lead screw *C*, and were the only gearing within the apron, except a screw nut *D* that was added for use in cutting long screws.

On the shanks or spindles of these tangent wheels, outside the apron, were spur wheels *E*, the pairs meshing together vertically, a pinion *F* connecting

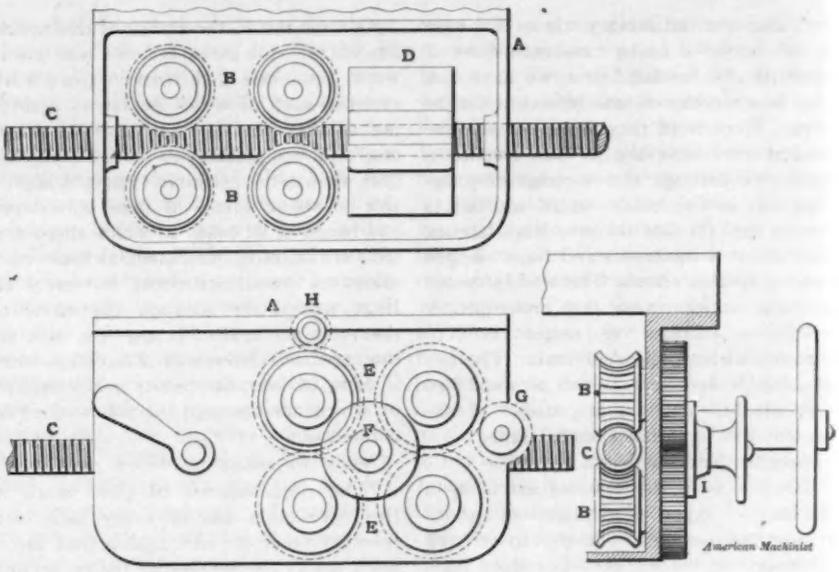


Fig. 74
FEED MECHANISM FOR A LATHE.

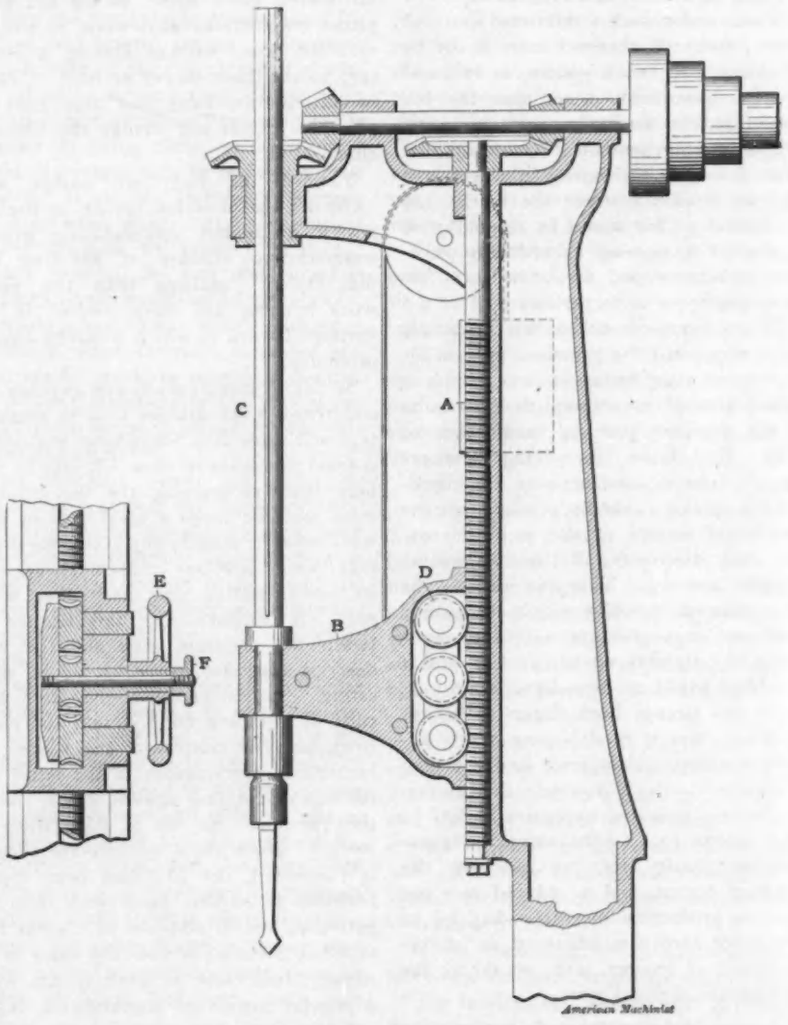


Fig. 75
FEED FOR DRILLING MACHINE.

the trains. A second pinion *G* was for the rack or hand transversing motion, and a third pinion *H*, geared to the cross-feed screw. This did not, however, end the functions. A loose washer plate *I* that

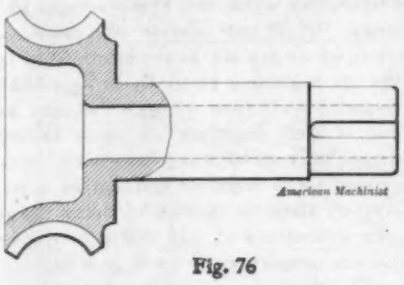


Fig. 76

bore upon the wheels *E* and pressed them against the front of the apron, formed complete and instantly starting friction feed motion.

This method of gearing is deserving of some study because it is doubted if the same number of functions can in any other manner be obtained by gearing equally simple, or at so little cost. For example: A rest or support for the screw, a nut for the screw, rack motion for traversing the carriage, an instantly starting friction feed, all driven from a common lead screw. The cross feed is not mentioned because that requires the carriage to be locked on the bed, answering very well when there is a compound rest, but in other cases inconvenient. This gearing was applied to a large number of lathes, fifty or more, and so far as known, has operated successfully.

Fig. 75 shows an application of the same kind of gearing to a drilling machine, so arranged as to produce a quick rack motion upward or downward, and either a positive or pressure feed of the spindle at will. The feed screw *A* is

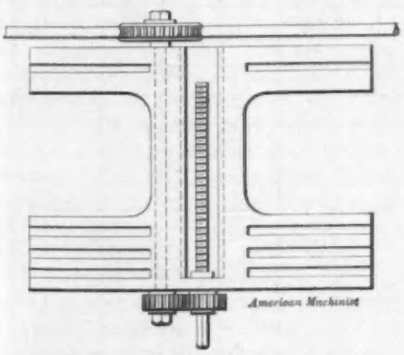


Fig. 77

PLAN OF ENGLISH LATHE CARRIAGE.

driven at the speed required for drilling and rests in a concave seat in the main frame. The bracket *B* is moved with the spindle *C* by means of the tangent wheels *D*. These latter are not geared together as in the former case. The stem of the center wheel projects to receive the hand wheel *E*, and, as shown, is drilled through to receive a screw that operates a clamp bar that bears upon all of the tangent wheels, pressing them against the inside of the bracket *B* by means of the small hand wheel *F*, producing a friction or pressure feed of the spindle, or a positive one, as this wheel is set with more or less force.

As to what the endurance of this arrangement may be I have no knowledge. A few machines were made in this manner and passed out of my observation. The chances are, however, that the wear of the tangent wheels forms an objection. Other modifications of this gearing will suggest themselves to the reader. It can be applied in various ways, and in almost any case has the characteristics of either a positive or yielding feed, furnishing a rack motion for quick movement and support for the feed screw.

For horizontal saddles the trains of the

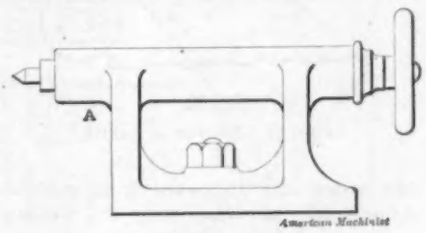


Fig. 78

FOOT-STOCK OF ENGLISH LATHE.

tangent wheels can be set vertically and the wheels disposed in pairs as in Fig. 74. They should be made of hard brass, cast integrally with their stems as shown in Fig. 76, and will be found durable because of the great extent of their wearing surface.

The modern method of rack-feed gearing for lathes is evidently a type that will endure, but open to the objection of involving a lot of devices that are enclosed in an apron and quite inaccessible; also in most cases perishable. English makers, who have a dread of small encased details, put the motion rod at the back of the lathes and transfer to the front by a small shaft through the carriage, parallel to the cross-slide screw, as shown in Fig. 77.

This forms a convenient means of gearing to the cross screw, also to the rack gearing in front, but is open to the objection that no portion has movement rapid enough to admit of clutches for friction gearing and instantaneous starting and stopping. The best that can be done is to clutch the tangent wheel *A* at the back, and that requires a good deal of pressure.

Speaking of the transfer shaft *B* passing through the lathe carriage introduces a matter that may properly be mentioned here. Everyone who has noticed the fact is aware that English makers give their lathe carriages much greater width between the heads than is common in this country. This is owing to the construction of the foot-stocks, which in their lathes project over the carriage, as shown in Fig. 78, enabling them to be increased in width proportionately.

In this country it is common to make the foot-stocks nearly flush on the front, and this demands a narrow carriage in order to bring tools to the end of pieces in the lathe. The only reason for this construction is that the beds can be made that much shorter; which does not seem a very good reason for narrowing a carriage in its main member.

Another modification of feed gearing that will have some interest is shown in Fig. 79, applied to a drilling machine. It is a simple screw feed, but so arranged as to be completely housed in the frame, is simple in construction and durable. *A* is the driving pinion, and *B* the feed pinion which can be operated by hand or driven by power. The spindle can be taken out by removing the nut *C* at the top, and the gearing removed by taking out the shell *D*. The screw is prevented from turning by a ledge or rib *F*. Other features will be clear from the drawing which was made from a working machine with a spindle 2½ inches diameter.

These remarks on feed gearing and the examples given are not to suggest substitution for, or to find fault with common practice which is ingenious and efficient, but subject to the criticism, especially in lathes, of too much mechanism, that by reason of its numerous details and light proportions becomes the most perishable

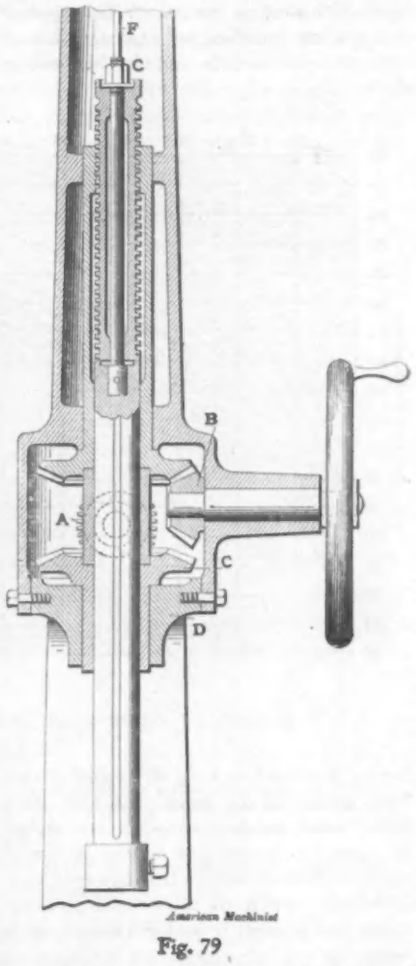


Fig. 79

FEED MECHANISM FOR DRILLING MACHINE.

part. There is also the fault of changing the rate of feed "in stages" which to be overcome requires sliding surfaces or friction gearing of some kind. Messrs. William Sellers & Co. have no doubt reduced such mechanism to one of its most simple forms and provide a graduated feed motion for their machine tools, but at an expense that is hardly warranted by the commercial conditions or the popular understanding of the matter.

There is too little use of the pawl-

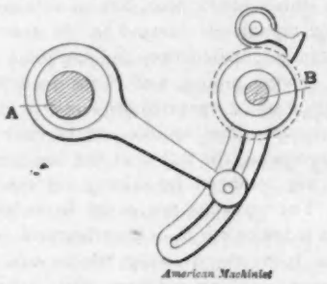


Fig. 80

RATCHET FEED FOR DRILLER.

ratchet method of feeding, which is the most simple of all and is well adapted in any case where there is some elasticity, as in drilling, answering, however, in all cases, except for abrupt movement as in slotting machines. The diagram, Fig. 80, represents what is meant. When applied to a drilling machine, for example, *A* may represent the spindle and *B* the feeding shaft.

The overhead rocking shaft and ratchet feed employed for large face and other lathes when the tool supports are shifted to various positions and angles, is one of the best feeding devices that has ever been invented, capable of all kinds of adjustment, and is positive and durable in every way.

I have employed ratchet feed for screw-feeding engine lathes as indicated in Fig. 81, and found it to occupy a lateral space of only an inch or so beyond the lathe head, permitting a graduated feed, easy reversal, and not interfering with the wheel train in screw cutting. This seems

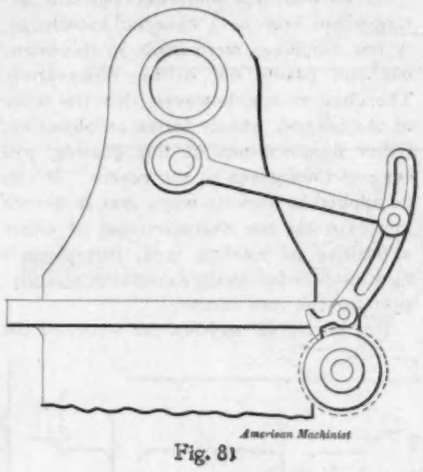


Fig. 81

RATCHET FEED FOR A LATHE.

like progressing backward from modern refinements, but true progress consists sometimes in what seems retrogressive practice. The feed shown in Fig. 81 was applied on what were called "blacksmith's lathes," for rough work, and it is remembered that the workmen who made the lathes pronounced it the best feed gearing of all among various other methods for lathes of a higher class.

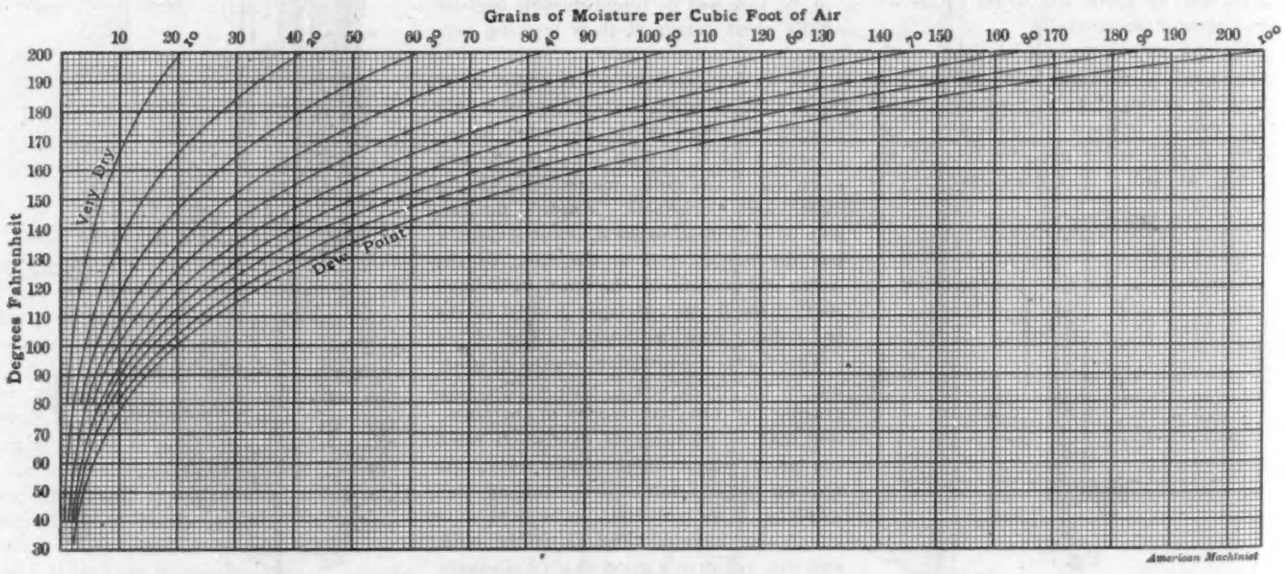


Fig. 1

WEIGHTS OF WATER VAPOR AND PERCENTAGES OF SATURATION OF ATMOSPHERIC AIR AT DIFFERENT TEMPERATURES.

Mixtures of Air and Watery Vapor

BY FRANK RICHARDS.

"Air is the respirable fluid which surrounds the earth and constitutes its atmosphere." That is the Century Dictionary definition of it, and it might as well have said that "air is air, you know." The up-to-date definition of air makes it the highly superheated vapor of a hitherto unfamiliar liquid which boils at temperatures far below that of our usual surroundings. Beginning far down in temperatures, air is first a solid like ice, then a liquid like water, and finally a vapor like steam. If it has a state still more attenuated we are not as yet informed of it. We are beginning generally to have more respect for air than we once had, and we find it well deserving of much further study. Since we have begun to talk of compressed air so much we find that air, whatever its state, is capable of many things once undreamed of, and that it may some day cut proportionally as large a figure in man's operations as in those of Nature.

I offer here two or three diagrams which have been of service to me in enabling me to realize and to familiarize myself with one or two of the important properties of air. Although these diagrams have to do only with air at ordinary atmospheric pressure, I call them compressed air diagrams, simply because all air is compressed air, the mere point of pressure at which we commonly encounter it being an accidental one, the air being capable of still further compression in one direction or of practically unlimited expansion (or de-compression) in the other.

These diagrams have to do with the conveyance of moisture by the air, one of its most important functions, and they are specially interesting at the present time because the problem of controlling the relative humidity of air, and also its temperature, by means of its artificial compression and expansion is one which is engaging considerable attention among engineers. I happen to know that some of the refrigerating machine companies are studying how to supply apartments with an atmosphere both the humidity and the temperature of which may be precisely

predetermined and controlled, at the same time that a constant supply of fresh air is maintained. There is a practical demand for a controlled atmosphere, both for the health and comfort of individuals and for the facilitating of many industrial operations. In the textile industries an abnormally moist atmosphere is often imperative, while in some others, as in the manufacture of glue and of the films used in photography, a dry atmosphere is just as much needed. It is quite possible to control these conditions by the mechanical treatment of the air. Especially is it possible to dry the air. It may be said, with a near approach to truth, that all air contains moisture. Probably the driest air in the world, or the air most free from the vapor of water, the only dry air, is liquid air.

Of common atmospheric air, as we usually encounter it, the same air, with the same amount of moisture in it, may be to us either "wet" or "dry," according to its temperature. The interesting diagram, Fig. 1, which is reproduced from one of the publications of B. F. Sturtevant & Co., Boston, shows this very clearly. In the diagram the vertical lines indicate the grains of moisture in a cubic foot of air at the normal atmospheric pressure of 14.7 pounds per square inch. The horizontal lines show the temperatures in degrees Fahrenheit, while the curved lines are for the percentages of humidity, from 10 per cent. in the line at the extreme left to 100 per cent., or complete saturation, in the line at the right or under all the others. Referring to this diagram, we may note that at a temperature of 40 degrees the air is saturated, or has all the watery vapor that it will carry, when it contains only 3 grains of water to the cubic foot; while at a temperature of 115 degrees air which has in it only 3 grains of moisture is very dry air, or has only 10 per cent. of the moisture which it would carry at that temperature. If this air came in contact with anything moist it would absorb the moisture with great avidity, or would have a rapid drying effect. Air at a temperature of 100 degrees is saturated with 20 grains of vapor, but becomes very dry air if its temperature is raised to 200 degrees. At the latter temperature it takes over 200 grains of water to saturate a cubic foot of air, or fully ten times as much as was required at 100 degrees. It is to be understood throughout that in the mixtures of air and water here spoken of, the vapor is absolutely invisible, and the damp air is as clear and transparent as the dry air. Visible moisture in the air is water in minute globules which either has not yet been absorbed by the air, or which has been released or precipitated from saturated air.

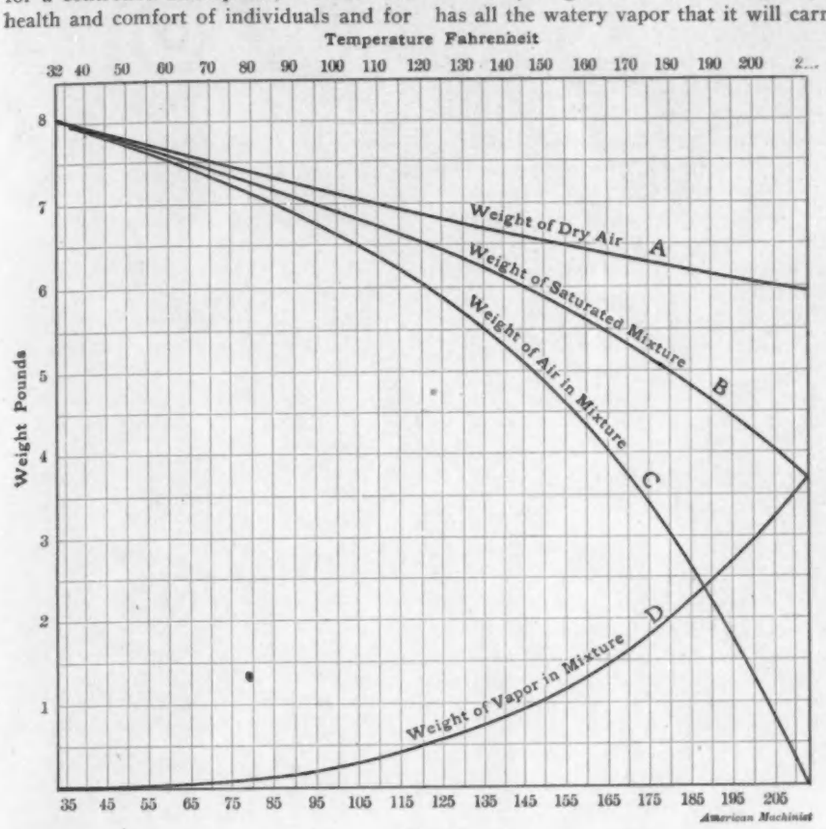

Temperature Fahrenheit
32 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Weight Pounds
8 7 6 5 4 3 2 1
Weight of Dry Air
A
Weight of Saturated Mixture
B
Weight of Air in Mixture
C
Weight of Vapor in Mixture
D
35 45 55 65 75 85 95 105 115 125 135 145 155 165 175 185 195 205
American Machinist

Fig. 2

WEIGHTS OF 100 CUBIC FEET OF DRY AIR, OF A SATURATED MIXTURE OF AIR AND VAPOR AND OF THE AIR AND VAPOR IN THE MIXTURE, AT VARIOUS TEMPERATURES.

The diagram Fig. 2 I have drawn from a valuable table in D. K. Clark's book. The air in this diagram also is at the normal atmospheric pressure of 14.7 pounds, and at various temperatures, the weights of air and of water in saturated mixtures being indicated by the several curves. The vertical lines are the lines of temperature, and the horizontal lines are those of weight. The diagram shows quite clearly the curious fact that dry air is always heavier than moist air, and that the difference in weight between a given volume of dry air and an equal volume of air saturated with watery vapor is greater at high temperatures than at lower ones. Since the mixture is lighter than the dry air, any given volume of the mixture does not represent that volume of dry air with the moisture added, but the vapor has par-

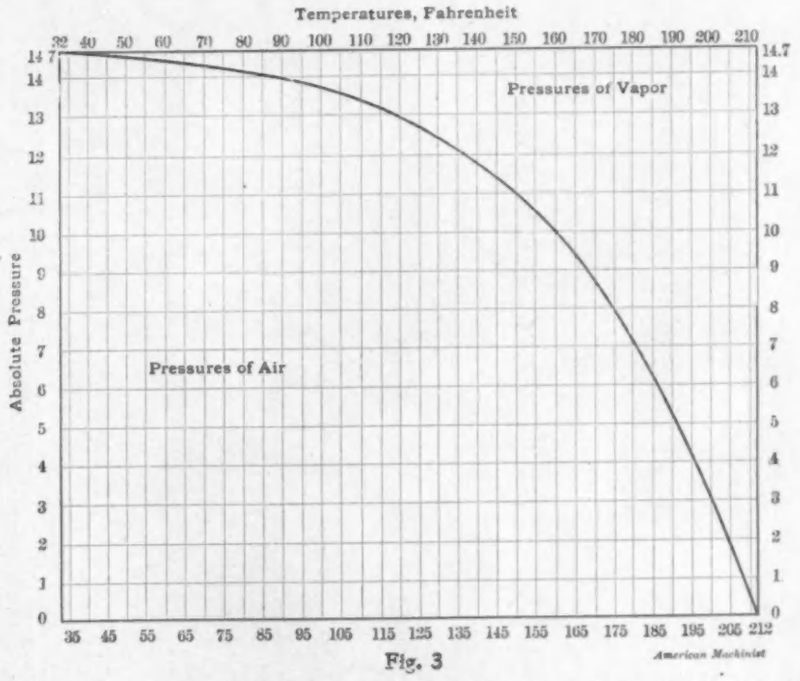


Fig. 3

PRESSURES OF AIR AND OF VAPOR IN A SATURATED MIXTURE AT ATMOSPHERIC PRESSURE AND AT VARIOUS TEMPERATURES.

tially taken the place of the air. There is not as much air by weight in a mixture of air and vapor as there would be in the same volume of dry air at the same pressure and temperature.

The diagram Fig. 3, also drawn from figures given in a table by D. K. Clark, shows how this can be. It is found that in these mixtures, at whatever pressure, the pressure is divided between the air and the water, or partially sustained by each, and the weight of each in the mixture is then determined by its independent pressure and their common temperature. The curved line in the diagram shows how, while the temperature increases, the pressure and consequent weight per volume of the air decrease, while the change of the vapor is the reverse of this, and as the weight of the vapor of water is less than that of dry air at the same temperature and pressure, the weight of the mixture is also less.

Sines and Tangents.

A correspondent who has become confused between sines and tangents of angles, and between the definitions of those functions as ratios and as lines, has asked for some explanations which will remove his difficulties, and we have pleasure in making the attempt.

In the older books on trigonometry the functions were all defined as lines. A circle, Fig. 1, was drawn with unit radius, and the sine of the angle $a\,b\,c$ was then defined as the length of the line $d\,e$, while the tangent was defined as the length of the line $f\,g$, and the tables were constructed to give these lengths. With a radius other than unity, the actual length of the lines may obviously be obtained by multiplying these tabular values by the radius.

It will be noticed that since $b\,e$ is the radius with a value of unity, if the line $d\,e$ be divided by $b\,e$ the numerical value of the quotient will be the same as the length of the line $d\,e$, but that this quotient is a line divided by a line, that is an abstract quantity or a ratio. Moreover, regardless of the size of the circle, the result will be the same, since doubling the radius $b\,e$ will also double the length of the line $d\,e$, and the ratio between the two will not be altered. In other words, the circle may be left out of consideration, as in Fig. 2, and regardless of the size of the triangle we may say that $\frac{d\,e}{b\,e}$ is the sine of the angle $d\,b\,e$, by which method the angle and the sine are directly connected together without reference to the circle or to the size of the triangle.

In the same way, since $b\,f$, Fig. 1, is also the radius—unity—if the line $f\,g$ be divided by $b\,f$ the numerical value of the quotient will be the same as the length of the line $f\,g$, this quotient being again a line divided by a line or a ratio and independent of the size of the triangle or of any consideration of the circle. We may then say that $\frac{f\,g}{b\,f}$ is the tangent of the angle $a\,b\,c$. From similar triangles $\frac{e\,d}{b\,d}$ has the same value, and without regard to the size of the triangle we may say that $\frac{e\,d}{b\,d}$, Fig. 2, is the tangent of the angle $d\,b\,e$.

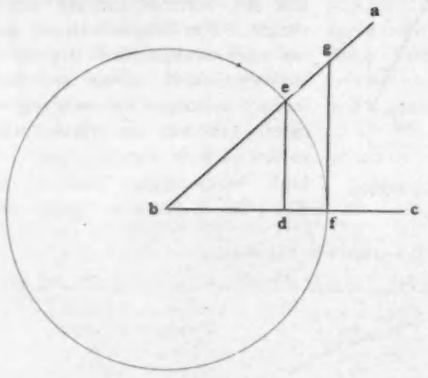


Fig. 1

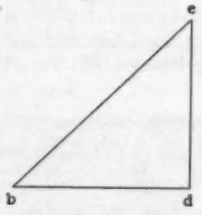


Fig. 2

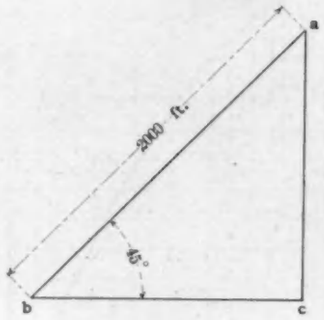


Fig. 3 SINES AND TANGENTS.

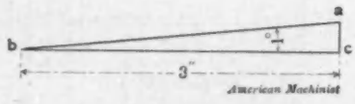


Fig. 4

As with the older method, if we wish the actual of the length of the line $d\,e$, the other dimensions being other than unity, we may take the sine of the angle as obtained from a table and multiply it by $b\,e$, because since $\frac{d\,e}{b\,e} = sin.\ e\,b\,d$, therefore, $d\,e = b\,e \times sin.\ e\,b\,d$.

Or we may find the length of $d\,e$ by multiplying the tabular value of the tangent by $b\,d$, because since $\frac{d\,e}{b\,d} = tan.\ e\,b\,d$, therefore, $d\,e = b\,d \times tan.\ e\,b\,d$.

We have thus two methods of finding the length of $d\,e$—one employing the sine, and the other the tangent. If, in any given case, we know the length of $b\,e$ we will naturally use that in connection with the sine, while if we know $b\,d$ we will as naturally use that in conection with the tangent. It will be seen that the sine compares the length of $d\,e$ with the length of the slope, while the tangent compares it with the length of the base.

Thus, if we have a line of water pipe, $a\,b$, Fig. 3, 2,000 feet long and located at an angle of 45 degrees with the horizontal, and we desire to know the pressure at the bottom, we need to first find the perpendicular hight or head $a\,c$. Having the length of $a\,b$ we employ the sine and say

$$a\,c = a\,b \times \text{sine } 45 \text{ degrees.}$$
$$= 2{,}000 \times .707.$$
$$= 1{,}414.$$

If, however, we wish to make a taper reamer which shall have its flutes inclined 1 degree to the center line and desire to know what taper to make it, as measured by the calipers, it is plain that we must use the tangent because we must employ the length and diameter of the reamer in measuring it up; that is, we must employ the base and perpendicular of the triangle. Thus, in Fig. 4 for a reamer 3 inches long we say:

$$a\,c = b\,c \times \text{tangent 1 degree.}$$
$$= 3'' \times .0174.$$
$$= .0522''.$$

Since this gives the difference between the radii 3 inches apart, it must be doubled to get the difference in the diameters.

Had the length of $b\,c$ in Fig. 3 been known and used in connection with the tangent, and had the length of $a\,b$ in Fig. 4 been known and used in connection with the sine the results would have been the same. The use of the sine or the tangent is simply a matter of convenience determined by whether the base or slope of the triangle is given. It may be said also that the modern way of looking at angles is to regard them also as ratios, the value of an angle being the ratio of the length of its arc divided by the radius. Thus, both the angle and its functions become ratios and their relationships are logical, whereas by the old method we were asked to regard illogical relationships between angular magnitudes measured in degrees and the length of lines measured in inches. This newer method of measuring angles is

called circular measure and is universal among mathematicians. The use of the old tables using degrees and minutes compels the retention of the old idea, so far as angles alone are concerned, in actual practice.

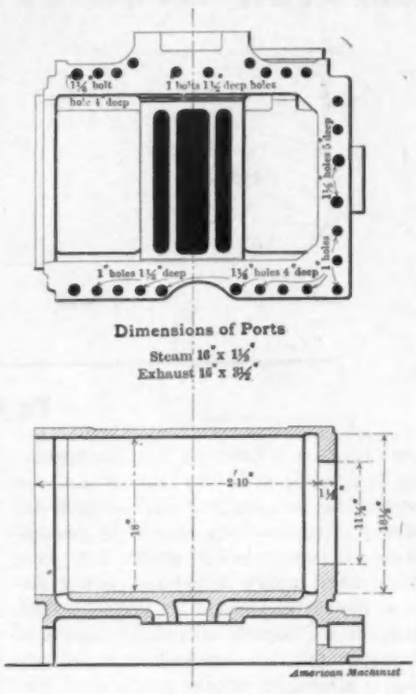
It is proper to add that while the view of the functions as ratios prevails in all modern text books, the old view still crops up in practice. Thus, so excellent a book as "Trautwine's Pocket Book" has a caption to its table "Natural Sines and Tangents to a Radius 1."

Letters from Practical Men

An Australian Cylinder Boring, Drilling, Milling and Slotting Machine.

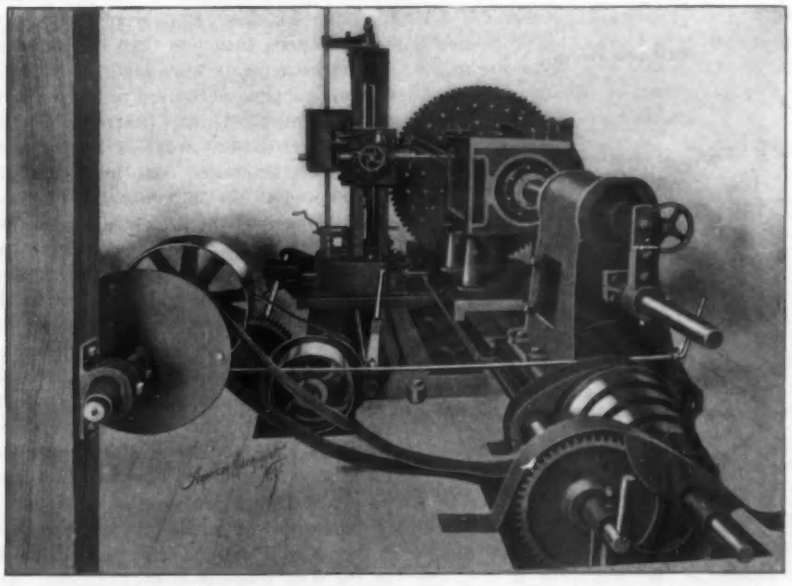
Editor American Machinist:

The accompanying photo is taken from a special machine tool we have running in our factory. It is designed and built for machining all classes of cylinders and for doing as many operations as possible on them at one setting. The machine is capable of dealing with cylinders up to 7 feet long by 44 inches bore, of either Corliss or ordinary slide-valve type. Both heads are movable, the far end one being provided with a powerful facing head. The boring bar is driven from both ends, and has a traveling head fed by a screw in either direction. The work table has a longitudinal movement, is actuated by a powerful screw, and can be driven either by power or hand. The back bed of machine is fitted with planing, slotting, milling and drilling attachments. The bottom portion or saddle has a compound movement, and is driven longitudinally by a powerful double-threaded screw. The cross motion is also obtained by a screw. On this saddle is fixed the vertical column carrying the tool heads. It has a circular base, and can be swivelled completely round or set to do work at any angle. In the photo the drilling and milling head is shown attached. It has an up and down movement. The full length of vertical column is raised and lowered by a screw, and can be swivelled to bore at any angle. Driving motion is obtained from the back vertical shaft. If planing or slotting is to be done, this head is removed and another suitable one attached, the change being made in a few minutes. When slotting, the head is driven by a double-thread screw in center of vertical column. Both planing and slotting movements have quick-return motions and are mechanically controlled. The length and positions of strokes can be varied as required. The driving cone for boring and facing is a six-step one, takes a 5-inch belt, and is provided with back gear. For driving the planing and milling head a 5-inch double belt is employed, and the necessary range of speeds for drilling and milling is obtained by cones on a separate countershaft. All feeds are positive and of large range in either direction, and all motions can be controlled either by power or hand. For boring Corliss valve seats a special head is attached to vertical column driving a bar similar to main boring bar, outer end of which is



DRAWING OF CYLINDER OF AUSTRALIAN LOCOMOTIVE.

supported by a stay attached to work table. The machine is shown operating on a locomotive cylinder. The dimensions of machined portions can be obtained from the accompanying tracing.



AN AUSTRALIAN CYLINDER BORING, DRILLING AND SLOTTING MACHINE.

Work to be done is: Part off the runner head, face both ends, bore and bell-mouth barrel, mill out ports, drill and shell-reamer all holes on joint face. In the photo the head has been parted off and bore just started; the drilling template is also in position. To forward the job all necessary planing had been done before this tool took the work in hand. The average time occupied in setting up and machining a cylinder as above described is 7 hours 40 minutes. One mechanic operates the machine, but has the assistance of a laborer when putting in and taking out work.

A Colonial Shop Manager.

[The writer of the above, who is manager of the shop in which the machine illustrated was built and is used, writes very appreciatively of the "American Machinist," and says that they have there numerous modern American machine tools, both large and small, which are giving every satisfaction. They were chosen, he says by means of information conveyed by this journal.—Ed.]

American Windmills in Switzerland.

Editor American Machinist:

I suppose Mr. Tecumseh Swift, in his article entitled "Windmill Inefficiency," in your issue of April 27, was not expecting to receive opposing testimony from a windmill business in Switzerland, and especially in relation to American windmills. As representative of the Aermotor Company, I introduce in Switzerland the type of windmill which, in design and in the arrangement of gearing, as well as in the fine steel tower upon which it is mounted, can scarcely be surpassed. I have erected several windmills, and they are not an easy thing to introduce here. I have four for pumping water for farmers and for village supply, which do their service in the best possible manner. But I would especially call the attention of Mr. Swift to one geared wheel employed

in a special service. It is a 16-foot wheel on a steel tower 50 feet high and placed beside the shop of a blacksmith. The lower end of the spindle has a 24-inch pulley belted to a 34-inch, driving a 15-foot horizontal shaft, which is connected to a 10-foot shaft by bevel gears; this forming the counter for an air-cylinder hammer with a 110-pound ram, and making 200 to 300 blows per minute. The shaft is also belted to two small drills. The blacksmith is a plow maker, and he forges the material for 400 or 500 plows a year entirely by this hammer, and has done so since 1897. He is exceedingly satisfied with this motor, giving him gratis 2½ to 5 horsepower, ready to use nearly every day in the year, and we have less wind than you have in some parts of America. The blacksmith is a sober and practical man, and he says: "I worked hard by hand, and now it is a light thing to prepare the work and to hammer it when the light breeze blows. Besides this, the drills are nearly all the day ready for use. I wish no more." That is, I suppose, a sample to consider, and the figures given are highly true.

In referring to the different articles criticising the worth of windmills, I think the storage of compressed air or of electricity worthy the attention of willing men. The skeptical are never contented. No 100-foot wheel is wanted, but several 16-foot wheels to give a power of considerable value and at one-third the cost.

FRANCIS L. MEYER.

Reckenbuhl, Luzerne, Switzerland.

Some Press Fits.

Editor American Machinist:

Valuable information showing how much a shrink fit is better than a force fit,

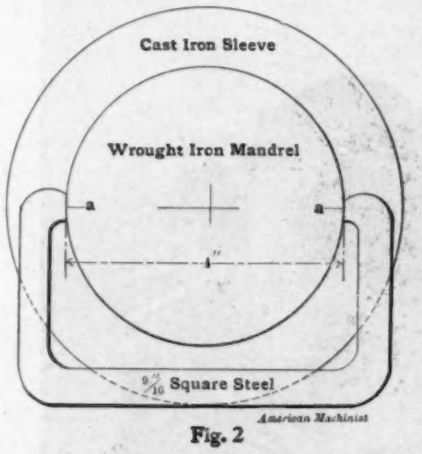


Fig. 2

and, in either case, how much more they hold in tension than torsion, is given in Professor Wilmore's paper in the "American Machinist" for February 16. As the surfaces of work that is shrunk together are dry, it would be reasonable to suppose the resistance would be greater than when lubricated and pressed together; but I cannot see why it should be greater in tension than torsion. Verily, there is nothing like an experiment to set one right in such cases.

I have always regarded the elastic limit of materials used in the construction of a machine as a sort of dead-line which it is never safe to approach closely, to say nothing of ignoring. There appears to be one exception to this rule, i. e., the shrinking or pressing fits. The limit of cast iron in tension, as usually given is .0006, yet .001 is often used. It should be remembered that the tension of the hub of a wheel, when shrunk or pressed on, is greater at the surface in contact with the shaft than at its outside diameter, and it is probably this condition that makes the higher allowance safe in practice.

In order to see how cast iron behaved under such conditions, I had a mandrel made of wrought iron, 4 inches in diameter and about a foot long. One end was turned down to 3½ inches, about 2 inches long, and the other end reduced about .004 inch, 1⅛ inches in length. Then two cast-iron disks were made, both 1 inch thick; but the diameter of one is 6 inches, the other 8 inches. Both were supposed to be bored .004 inch less than the mandrel. The measurements were made as follows: Outside calipers were used to get the sizes of the mandrel. One of Starrett's No. 120 inside micrometers was set to the calipers, then shortened .004 inch, and the disks bored to the micrometer. The outside diameter of the 8-inch disk was then taken with calipers, and the micrometer set to the calipers. The disk was then put on the mandrel, and both put in the testing machine, and the mandrel started into the disk till the end reached the top of table, as shown in Fig. 4, the object being to insure the mandrel being square with the face of the disk. The mandrel was then entered into a sleeve that was faced on each end and bored to slide over it. Then with a pressure of 8,900 pounds the mandrel was forced into the disk about 5 inches. Then the disk was calipered to see how much it had expanded. And right here the fun begins, for it was soon found that accurate measurements could not be made with outside calipers and inside micrometers in combination for such work.

The 8-inch disk was pushed off and the 6-inch forced on with a pressure of 5,600 pounds. The result was no more satisfactory with the 6-inch than with the 8-inch. All that was known was that the disks were larger when on the mandrel than when off, and that they were larger after having been pushed on and off than before. Another 8-inch disk was made and a system of measurement employed by which the outside diameter of disk could be determined to .0001 inch, and the difference between the diameter of mandrel and hole in the disk to .0005 inch or less.

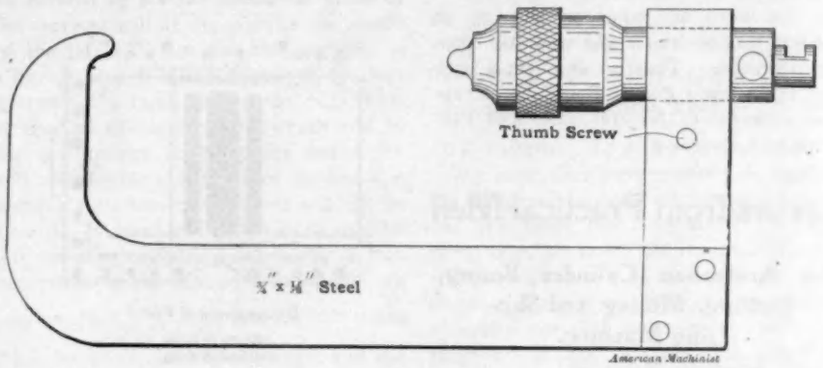


Fig. 3

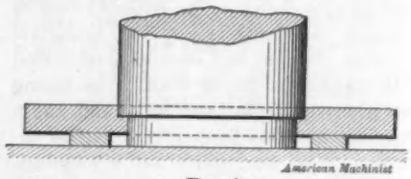


Fig. 4

A gage was made for the mandrel of 9-16 inch square steel, as shown in Fig. 2. The bottom side of the gage was surfaced, and then the surfaces *a a* were scraped and rubbed down till they were parallel, and would just touch the mandrel when both were at the same temperature. The top of the sleeve, spoken of before, made a very convenient guide for the gage to slide on while the surfaces were being worked down to fit the mandrel. It was then found that the mandrel was not quite round. No trouble was experienced in setting the micrometer to this gage; but setting a lathe tool to bore a 4-inch hole to within .0005 inch is quite another thing.

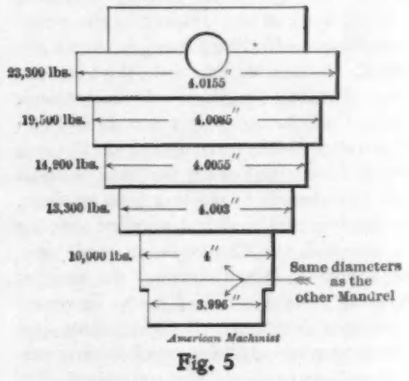


Fig. 5

However, that disk was bored .0045 inch smaller than the mandrel without a possibility of varying as much as .0002 inch either way. It should be stated that the micrometer was not graduated to read closer than thousandths; so the barrel was chucked in a lathe, and nine longitudinal lines put on the back to correspond with ten divisions on the thimble.

To determine the change that took place in the outside diameter of the disk two small lugs, projecting ⅜ inch above the face, and opposite each other, were fastened on with ¼-inch cap screws. The micrometer was wrapped with paper to protect it from the heat of the hands and breath, and ample time taken to adjust it accurately. The disk was then put on the mandrel and pressed on with a pressure of 9,300 pounds, up to the hole in the mandrel to put the micrometer through, as shown in the photograph. [The photograph referred to could not be used for half-tone purposes with good results, and we have omitted it. What it shows, however, is sufficiently indicated by Fig. 8.—Ed.] No change of shape could be detected in the disk, except its diameter, which was carefully measured and found to be .0016 inch larger than before. The mandrel had expanded the inside of disk .0045, as no compression could be found in mandrel. This ratio of internal to external enlargement would indicate that a 10-inch hub for a 4-inch shaft would be as large as

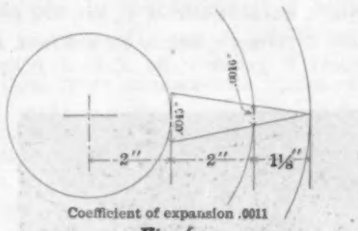


Fig. 6

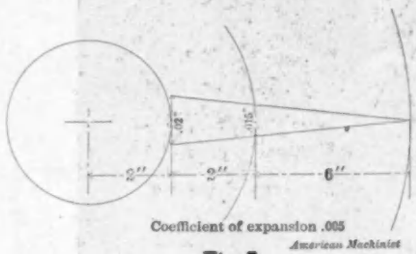


Fig. 7

there would be any use in making it with that coefficient of expansion. The method of determining this diameter (10 inches) is shown in Fig. 6. It required 11,000 pounds to start the disk back on the mandrel, and when off it was found to be .001 inch larger internally, and .0005 larger externally than before being pressed on.

The disk was then forced on a mandrel made as in Fig. 5. The various diameters and pressures required to force the disk

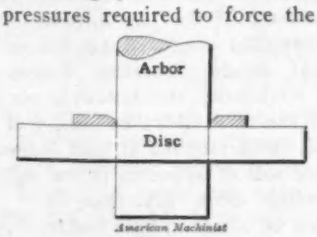


Fig. 9

on are shown on the sketch. It was thought that the largest diameter of mandrel would burst the disk, but it stood it O. K. The hole shown in the top of mandrel was made for the micrometer to pass through when getting the diameter of disk before it was pressed off, which was found to be enlarged .015 inch, while the inside was expanded just .02 inch larger than it was bored, indicating, as will be seen by referring to Fig. 7, that a 20-inch hub would be required for a 4-inch shaft if a coefficient of expansion of .005 is to be used. After being pressed off the disk was .004 larger outside and .009 larger inside than it was originally.

In making the measurements, the micrometer was first lengthened till it would lie at an angle, as in Fig. 8. Then after leaving it for, say, twenty minutes, to come to "thermal equilibrium" with the disk, the high end had not dropped. The micrometer was shortened and given another opportunity, and the operation was repeated till it did drop. Center lines were drawn on the lugs and the ends of the micrometer kept to them.

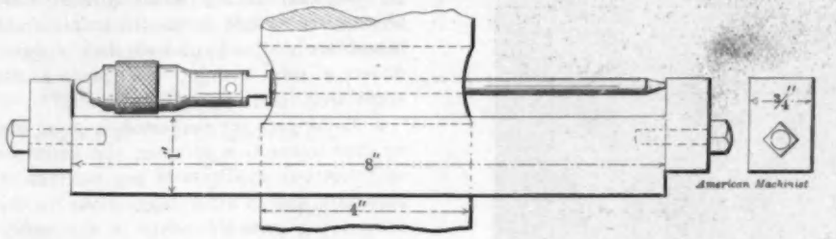


Fig. 8

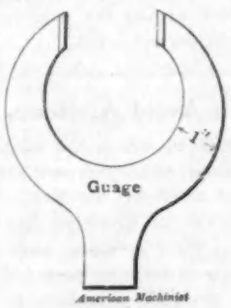


Fig. 10

It will be noticed that attention has been paid in the above to the compression of the arbor by the disks, and to satisfy myself (and the editor) on this point I made some experiments as follows:

The disk was pressed on the large arbor with 22,300 pounds. Then a gage was made to fit the arbor as close to the disk as possible, with almost knife-edge bearings, as shown in Fig. 9. The temperature of the room was 60 degrees, and there is no reason that I can see why the mandrel, disk and gage should not have been the same. The disk was now pressed off and the mandrel set up where it could be gaged in the same place and with similar supports for the gage. With the temperature of the room as before, the gage was put in a bucket of water having a temperature of 130 degrees (by same thermometer). Then, without waste of time, the gage was applied and was found to be too big for mandrel, and continued to be so until the temperature of the water and gage was reduced to 120 degrees. The gage was made of an old circular saw, close to 3-32 inch thick, and had an average width of about 1 inch. If the difference in the temperature of gage (see Fig. 10) and arbor was 60 degrees, as I am sure it was, then the compressure of shaft would be .00033 inch. It seems to me this method ought to give accurate results, and the compression of arbor, I suppose, may be assumed to be proportional to the force required to press the disk on the arbor, say .0001 inch compression 10r each 7,500 pounds force for other allowances.

Youngstown, Ohio. J. H. DUNBAR.

[It is open to question, we think, whether the conclusions drawn from Figs. 6 and 7 are fully justified or not. The converging lines would probably be curves instead of straight ones. But aside from this the results obtained by Mr. Dunbar are interesting and serve to throw some additional light on a subject about which comparatively little is known.—Ed.]

Horse Power and the Horse Hour.

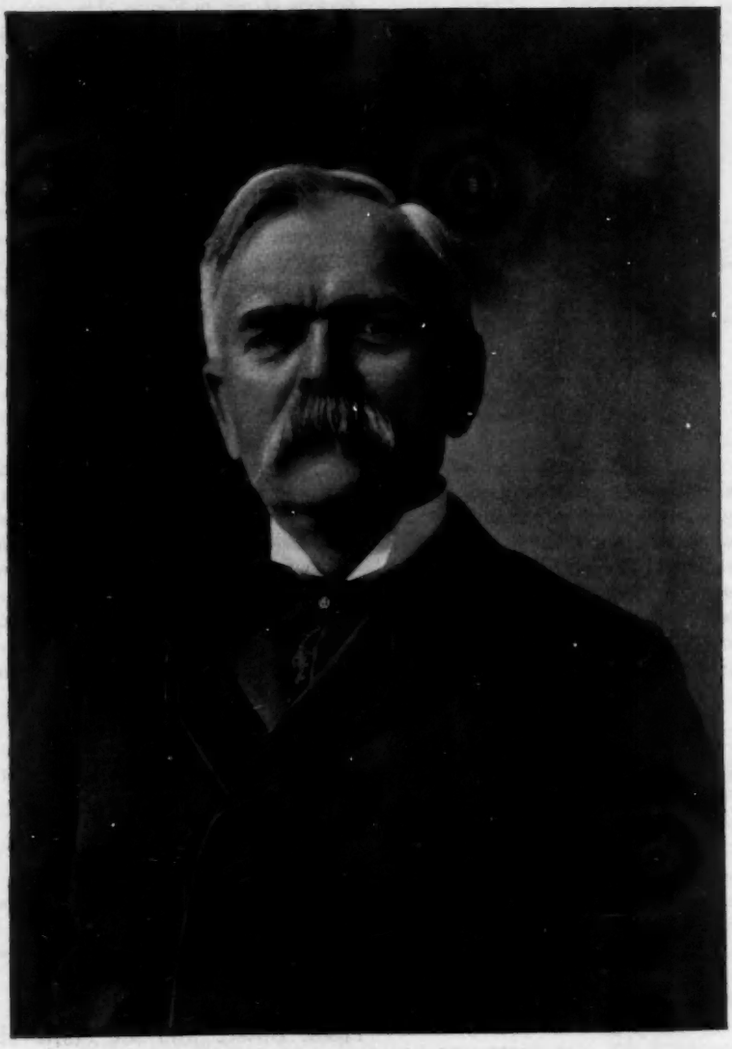
Editor American Machinist:

In the article on "Windmills and Compressed Air," in your issue of May 18, by Mr. Richards, he says that the 8-foot 6-inch wheel will do 999 foot-pounds of work per minute, which divided by 33,000 gives .0315 as the horse-power of the mill, and .0315 multiplied by 8, the number of hours run per day, gives .252 horse-power hour, so *that four days' running would be required to produce one horse-power.* Now, it seems to me that the 999 foot-pounds of work done per minute multiplied by the number of minutes in 8 hours would give the total work done by the mill in that time, and that sum divided by 33,000 would give the horse-power developed, which would be $\frac{999 \times 60 \times 8}{33{,}000} = 14.5$ horse-power. Am I right or wrong?

KANSAS.

[It seems to be well to reproduce the

above just as received, although Mr. Richards is not quoted correctly, as will appear in our following explanation. Our correspondent, if at all familiar with windmills, must know that an 8-foot 6-inch windmill will not do the work of 14.5 horses. Horse-power means, approximately, power equal to that of a horse, and a horse has only a horse-power, whether he works a minute, an hour or a day. It is convenient to measure, and to have the means of stating, the rate at which a horse will work, and also the amount of work done by him in any stated time, but the two things are not the same. Our correspondent may receive for his services, let us say, 50 cents per hour, and, if he does, that is his wage-rate. He may work 37 hours and receive for it $18.50, but his wage rate all the while will still be only 50 cents per hour. So, in any computations of work done the rate at which the work is done is one thing, and the total amount of work done is another. In the case of the windmill computation in the article referred to, the mean rate of work was 1039.8 foot-pounds per minute, and not 999, as given above by our correspondent. Then the total foot-pounds of work done in 8 hours would be: $1039.8 \times 60 \times 8 = 499{,}104$ foot-pounds. But a horse-power is 33,000 foot-pounds per minute, so that a horse-power for 8 hours is $33{,}000 \times 60 \times 8 = 15{,}840{,}000$ foot-pounds. Then 499,104 foot-pounds $\div$ 15,840,000 foot-pounds $= .0315$ horse-power, which proves the original figures to have been correct.—Ed.]



CHARLES A. BAUER.

To Avoid Accidents.

The degree to which the comfort and safety of their employees are considered and looked after by the firm of J. H. Williams & Co., of Brooklyn, has been referred to in these columns, and we print below a copy of recently posted directions and rules, designed especially to prevent accidents. These, the company write us, have been adopted after very careful consideration and consultation with the best authorities in such matters, and may be interesting to others.

1. The elevator is *for freight only.* All employees except the authorized elevator hands are forbidden to ride upon it, or to touch it in any way, except in the performance of their duties. All persons riding upon this freight elevator do so at their own risk.

2. All employees are forbidden to clean or repair any machine or machinery while it is in motion. Shafting in motion may be cleaned only by means of clamps or hooks in the manner prescribed by a foreman or assistant foreman.

3. All employees are forbidden to touch any machine or machinery which they have not been ordered to operate by a foreman or assistant foreman.

4. All employees are forbidden to be in any part of the works where their own work or where necessity does not require them to be.

5. Running, wrestling, scuffling or indulgence in any kind of play in any part of the works is dangerous and is forbidden.

6. All employees while working at or while near any machine or machinery in motion are cautioned against talking with any person except a foreman or assistant foreman.

7. All employees while in the works are cautioned against wearing loose sacks or loose or flowing sleeves.

8. Each drop-hammer has been supplied with one or more angle irons to prevent ram falling when lifted. Employees are *strictly forbidden* to put their heads, arms or any part of their persons under a ram without first placing the angle iron in its proper position.

9. Employees are requested to point out to their respective foremen the defective or dangerous condition of any machine or apparatus and to make suggestions for the purpose of ensuring safety in the operation of the works. Prompt and careful attention will be given to such suggestions.

10. No person employed by this company has authority to dispense with or modify the above rules.

11. Finally, *be careful!*

J. H. WILLIAMS & Co.

Sad End of a Noted Inventor.

In our issue of April 27 we briefly mentioned the death of John Louis Lay, an ex-engineer of the United States Navy and inventor of the Lay torpedo. In a more extended sketch of his life in the "Journal of the American Society of Naval Architects" the following occurs:

"For his own labors he was well rewarded, as he received at least $1,000,000 from the sale of torpedoes or the right to manufacture them. Like many other rare geniuses, he is said to have had no orderly business methods and no idea of the value of money, spending great sums on visionary experiments in the most prodigal manner. For these reasons his later years were made sorrowful by poverty, and he was on occasions saved from actual want

by the generosity of friends who had known him in the days of his prosperity and who appreciated the value of his contributions to the triumph of machinery that the last half of this century has seen. He died in Bellevue Hospital, New York, of erysipelas, April 18, 1899, so unknown that his name and history were not learned by the hospital officials until after his death. He leaves a wife, who has long lived in London, a married daughter in Java, and a son on the Pacific Coast. His body was sent to Buffalo, his boyhood home, for burial, and his papers relating to his share in the world's work will be delivered to the Buffalo Historical Society."

Laying Out Ball and Roller Bearings

The following question arises frequently in designing certain kinds of roller or ball bearings: Given n balls, disks or rollers of diameter d inches, in contact with one another and with an enveloping or enveloped cylindrical surface, or lying so that their centers are on a circle of given diameter, as in the case of the fifteen rollers shown in Fig. 1, what are the relations existing between d, n, D, R and S?

In the first place, it is obvious that

$$S = D + d \qquad (1)$$

and

$$R = D - d \qquad (2)$$

Also the angle $A\,O\,C$ is subtended by an arc which is equal to the circumference divided by the number of rollers, and hence

$$\text{angle } A\,O\,C = \frac{360^0}{n}$$

and angle $B\,O\,A = \frac{1}{2}$ angle $A\,O\,C$

$$= \frac{180^0}{n}.$$

Now,

$$A\,B = A\,O \sin.\left(\frac{180}{n}\right)^0,$$

or since $A\,B = \frac{d}{2}$ and $A\,O = \frac{D}{2}$, therefore

$$d = D \sin.\left(\frac{180}{n}\right)^0$$

$$\text{or } D = \frac{d}{\sin.\left(\frac{180}{n}\right)^0} \qquad (3)$$

Also from 1 and 2 it follows that

$$S = d + \frac{d}{\sin.\left(\frac{180}{n}\right)^0} = d\left(1 + \frac{1}{\sin.\left(\frac{180}{n}\right)^0}\right)$$

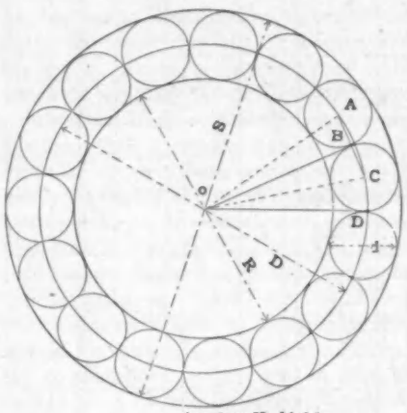
$$R = \frac{d}{\sin.\left(\frac{180}{n}\right)^0} - d = d\left(\frac{1}{\sin.\left(\frac{180}{n}\right)^0} - 1\right)$$

As, however, in most pocket books the table of sines is somewhat meager, whereas for even moderate accuracy the angle $B\,O\,A$ must be calculated correct to a second, the table has been calculated to enable draftsmen and others to avoid this trouble.

This table consists of seven columns. In the first column, designated n, is a row of figures indicating the number of rollers, commencing at 7 and ending at 30. Next in order comes a column of angles, whose values are $\frac{180^0}{n}$, where n is the number immediately to the left in the preceding column and in line horizontally; next comes a column of values of $\sin.\frac{180^0}{n}$; and then three more columns with values of

$$\frac{1}{\sin.\frac{180^0}{n}},\quad \left(\frac{1}{\sin.\frac{180^0}{n}} + 1\right),\ \text{and}\ \left(\frac{1}{\sin.\frac{180^0}{n}} - 1\right),$$

and lastly, for convenience, another column containing the same numbers as the first. The relationships existing between d, D, S, R and p for any value are shown in the sketch at head of the table.



American Machinist

S = diameter of enveloping cylinder = $C \times d$.

R = diameter of enveloped cylinder = $K \times d$.

d = diameter of balls or rollers.

D = diameter of circle on which ball or roller centers lie = $B \times d$.

n = number of balls or rollers.

BALLS AND ROLLERS IN CONTACT.

n	$\frac{180^0}{n} = \theta$	$\sin.\left(\frac{180}{n}\right)^0 = A$	$\frac{1}{\sin.\left(\frac{180}{n}\right)^0} = B$	$\frac{1}{\sin.\left(\frac{180}{n}\right)^0} + 1 = C$	$\frac{1}{\sin.\left(\frac{180}{n}\right)^0} - 1 = K$	n
7	25° 42′ 51.4″	.43389	2.3048	3.3048	1.3048	7
8	22° 30′ 0″	.38268	2.6131	3.6131	1.6131	8
9	20° 0′ 0″	.34202	2.9238	3.9238	1.9238	9
10	18° 0′ 0″	.30902	3.2360	4.2360	2.2360	10
11	16° 21′ 48.3″	.28173	3.5495	4.5495	2.5495	11
12	15° 0′ 0″	.25882	3.8637	4.8637	2.8637	12
13	13° 50′ 46.1″	.23932	4.1786	5.1786	3.1786	13
14	12° 51′ 25.7″	.22252	4.4940	5.4940	3.4940	14
15	12° 0′ 0″	.20791	4.8097	5.8097	3.8097	15
16	11° 15′ 0″	.19509	5.1258	6.1258	4.1258	16
17	10° 35′ 17.6″	.18375	5.4422	6.4422	4.4422	17
18	10° 0′ 0″	.17365	5.7588	6.7588	4.7588	18
19	9° 28′ 25.2″	.16459	6.0755	7.0755	5.0755	19
20	9° 0′ 0″	.15653	6.3925	7.3925	5.3925	20
21	8° 34′ 17.1″	.14904	6.7095	7.7095	5.7095	21
22	8° 10′ 54.5″	.14231	7.0267	8.0267	6.0267	22
23	7° 49′ 33.9″	.13617	7.3439	8.3439	6.3439	23
24	7° 30′ 0″	.13053	7.6613	8.6613	6.6613	24
25	7° 12′ 0″	.12533	7.9787	8.9787	6.9787	25
26	6° 55′ 23″	.12054	8.2963	9.2963	7.2963	26
27	6° 40′ 0″	.11609	8.6138	9.6138	7.6138	27
28	6° 25′ 42.8″	.11196	8.9314	9.9314	7.9314	28
29	6° 12′ 24.8″	.10812	9.2491	10.2491	8.2491	29
30	6° 0′ 0″	.10453	9.5668	10.5668	8.5668	30

TABLE FOR BALL AND ROLLER BEARINGS.

ROBERT A. BRUCE.

New Brompton, England.

An Universal Electric Wiring Chart.

BY LAWFORD H. FRY.

The practical engineer is continually being confronted by various classes of problems, such as the determination of the strengths of bolts, the calculation of the capacity of electric conductors, etc., where the problems of each class are solved by the application of a formula characteristic of the class.

Take, for example, the problems of the class to which the present article is devoted, those pertaining to electric wiring for the transmission of energy. Here the constituent factors of the problems are the length (l) of the conductor, the current (c) carried by the conductor, the area (a) of the conductor, and the loss of potential (p) in the conductor. These factors vary with the problem, and a further invariable factor or constant is involved—the specific resistance (s) of the material of the conductor.

As the result of many experiments and calculations, a definite relation has been established between these factors, so that if all but one of them are known, the value of the missing factor can be determined by calculation. For instance, if, taking the general case, we represent the factors by the letters bracketed after them as above, their relation to one another will be expressed by the formula:

$$a = \frac{l\,c}{p}\,s.$$

If all but one of the factors are known, this becomes a simple algebraic equation for the unknown factor.

The chart given herewith was constructed to solve this equation for all ordinary values of the factors.

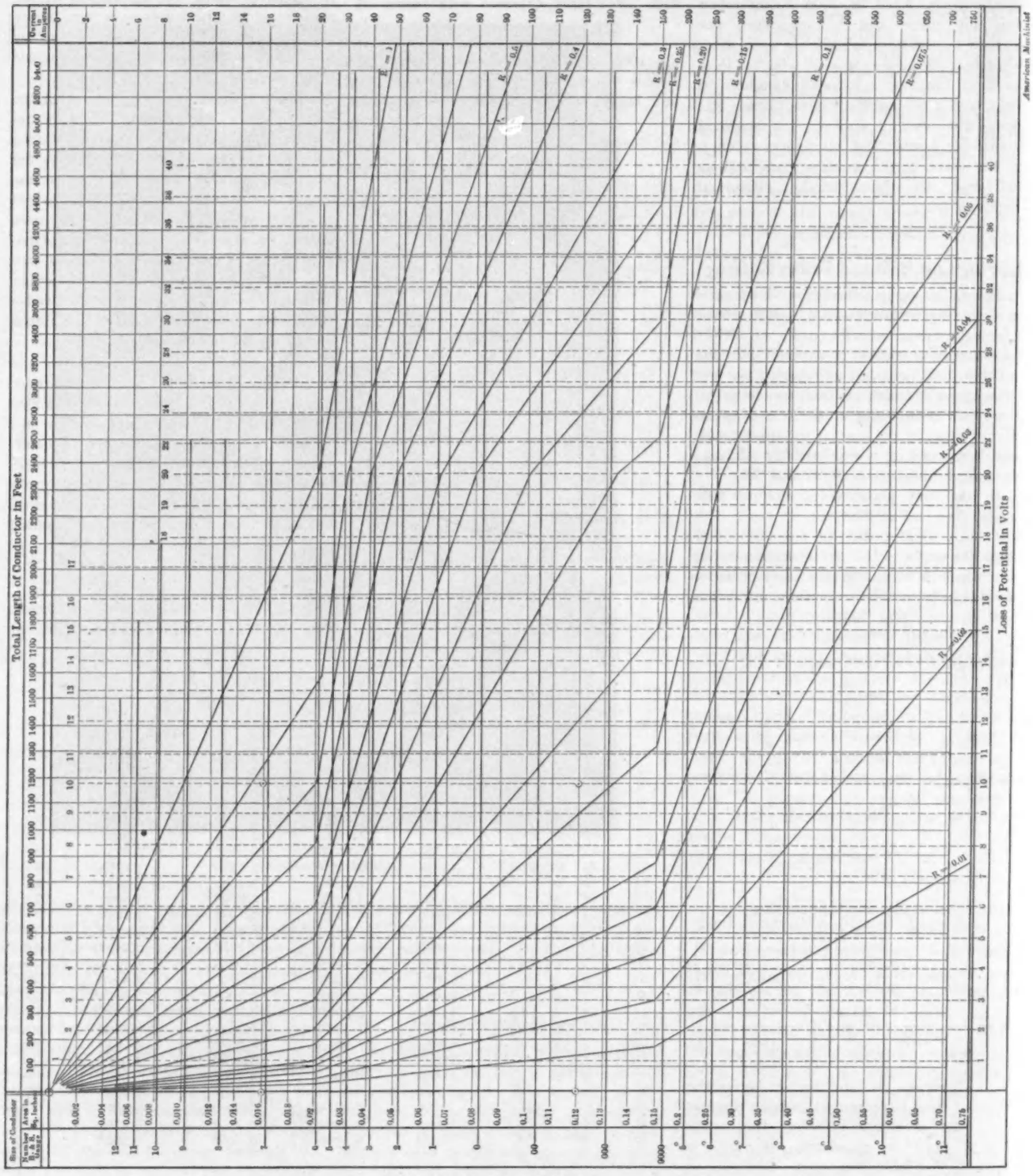
Along each of the four sides of the chart scales are marked, corresponding to the four variable factors of a wiring

problem. The scales along the bottom and top refer to different sets of lines; the top scale of conductor lengths referring to the full vertical lines, and the bottom scale of potential loss to the dotted lines.

Take as an instance of a problem to be solved by the chart, the following: A current of 20 amperes is to be carried a distance of 150 feet with a loss of potential of 5 volts; what size wire is required?

In the scale of currents at the right-hand end, we pick out the horizontal line marked 20 amperes, and in the lower scale we choose the vertical dotted line marked 5 to correspond to the loss of potential. Then we find the point of intersection of these two lines. Through this point passes a diagonal line, and we follow along this till it finally intersects the full vertical line marked on the top scale with the length of the conductor. In the problem proposed above, this will be twice the distance the current is to be carried, or 300 feet. Now a horizontal line drawn through the final intersection point gives on the scale of areas at the left-hand side of the chart the requisite area of the wire. Since only in very exceptional cases will anything but standard wires be used, heavy horizontal lines corresponding to the sizes of the B. & S. wire gage have been drawn across the chart.

In the case we are considering, such a



ELECTRIC WIRING CHART.

heavy line passes through the intersection of the diagonal we found and the 300-foot vertical. Referring to the columns at the extreme left, we find that the horizontal line is that for number 9, B. & S. gage.

Then the loss of potential in 300 feet of No. 9 wire carrying 20 amperes is approximately 5 volts.

The chart is not only applicable when the size of the wire is the unknown quantity, but will prove equally useful in solving problems with any of the other three factors to be determined. It is hardly necessary to give instances of the working of the chart in all these cases, but the following general rule should be noted:

Of the four variable factors two pertain to the current, viz., magnitude of current and loss of potential; and two, size and length of wire, relate to the conductor. In applying the chart to the solution of a problem the first step is to pick out from the data the two factors which pertain to the same element. The point of intersection of the lines for these two factors gives the diagonal which solves the problem.

The diagonals are lines of equal resistance, and at the lower end of each will be found marked the resistance in ohms to which it corresponds. This fact gives the reason for the method of procedure given above.

The size and length of a wire determine its resistance; and with current and loss of potential given, the resistance causing this loss is fixed. If for any problem the diagonals are too far apart to give a sufficiently accurate solution, other diagonals can be drawn in through any point without any further calculation.

The scale of the chart is changed once in the horizontal direction and twice vertically. As a result of this the diagonals appear as broken lines, and an examination will show that the diagram is composed of six "fields," in each of which the diagonals are straight lines. Each field has a point in which the diagonals would meet if produced. These points are marked on the chart, and the drawing of a diagonal in any field is then merely a matter of joining the point to the common meeting point for the field. To continue the diagonal we join the points where it enters the adjacent fields to the common meeting points of those fields.

The chart has been constructed for wires having a specific resistance of 75 per cent. of that of pure copper.

A few weeks ago we published some account of an electric cannon alleged to have been invented by an apprentice in Whitehead's torpedo works, and for which invention the English Admiralty was said to have offered £75,000. The story was taken from an English paper not known to be "yellow," but it is now contradicted and pronounced an unmitigated fake.

Death of Charles A. Bauer.

As briefly announced in our issue of last week, Charles A. Bauer, of Springfield, Ohio, died June 12. The immediate cause of his death was a surgical operation undertaken as a last resort in the hope of saving his life, he having been attacked by peritonitis. At the time of his death Mr. Bauer was fifty-two years of age, having been born in Wurtemburg, Germany, in 1847. His father was a draftsman, and when his son Charles was five years old sailed with his family for America, landing at New Orleans, where within a year the father died of yellow fever, and his widow, seeking a healthier locality in which to bring up her children, moved to Cincinnati. Here at a tender age young Charles found it necessary to go to work, in order to contribute something to the family's support, and his first employment was in a fireworks manufactory. His natural taste for engineering led him, however, successively into a gun-making establishment and an engine shop, and his leisure time was spent in studying mathematics, the science of mechanics and drafting, to such good purpose that in 1867, at twenty years of age, he became a teacher of mechanical drawing and applied mechanics in the Ohio Mechanics' Institute at Cincinnati. This position he held for some years, and finally resigned it to become superintendent of the Niles Tool Works, rendering to that institution valuable service at a formative period of its career. Later he was connected with the Lane & Bodley Company, of Cincinnati, in an engineering capacity, and in 1875 became nominally assistant superintendent, but really the directing mind of the Champion Bar & Knife Works at Springfield, Ohio, a large and excellently equipped factory, built under his direction, for the manufacture of cutter bars and knives for the harvesting machinery manufactured by the Champion interests. Later he became superintendent, in addition, of the large malleable iron foundry controlled by the same interests, and in 1883 became general superintendent of the Warder, Bushnell & Glessner Company, of the same city. This establishment, which was already large, grew larger under his management, and in becoming larger also became better, and is at this time one of the best organized and equipped manufacturing establishments of the country, although some portions of its plant are quite old. At the time of his death Mr. Bauer was part owner of the establishment (which is incorporated), and was in general charge of the business. His career, which was more than ordinarily successful, constitutes an excellent example of what persistent energy, natural talents and a good constitution can do for their possessor when rightly made use of.

Personally, Mr. Bauer was a very engaging man. He seemed incapable of uttering a harsh or brutal word, or of entertaining the thoughts from which such words spring, no matter what the provocation might be. He possessed the rare and valuable faculty of having things go his way without arousing opposition unnecessarily; he was always courteous and self-possessed, ready to hear the other side and to judge fairly according to the best of his ability. His own early struggles seemed to make him the more ready to assist those whom he found taking an interest in the science of mechanics, and long after he had become a busy man of affairs he taught classes in drawing and was always ready, in or out of the shop, to assist anyone seeking helpful information. Mr. Bauer was a charter member of the American Society of Mechanical Engineers, and was one of its managers during 1894-97. He was vice-president of the newly formed Foundrymen's Association, and had rendered valuable service to the city of Springfield as waterworks trustee. He was chairman of the commission appointed to remodel and add to the Ohio State House, and told the writer some time ago that he expected there would be an unexpended balance of the appropriation made for that purpose, which balance would be turned back into the State treasury. Many of the good ideas presented in these columns by James W. See in his letters entitled "Extracts From Chordal's Letters" were taken from Mr. Bauer's practice, and the writer of those letters once referred to him (though not by name) as "one of the best machine shop managers in the United States," a judgment in which all who had opportunities for observation will heartily concur.

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer by mail.

(59) E. H. M., Canton, Ohio, asks for formula for cement to fasten wood to cast iron for use in pattern work. A.—A cement recommended for fastening wood to iron is made by dissolving glue in boiling water, making it of the consistence of cabinet-maker's glue, and then, while stirring, add a sufficient quantity of wood ashes to produce a mixture resembling varnish. The surfaces to be united are heated and covered with this cement and allowed to cool. We doubt, however, if this cement will prove entirely satisfactory for pattern work unless it is supplemented by some form of fastening, such as screws or dowel-pins.

(60) J. B. L., Charleston, S. C., asks: What is the precise meaning of the word "oblong"? A.—The word seems to have no very precise meaning, or at least to be permitted wide departures from precision in practice. Assuming an oblong figure to be a rectangle, one dimension of which is decidedly larger than the other,

which is one of the dictionary definitions of it, if we permit the corners of the rectangle to be rounded and still be included in the term "oblong," then, according to the degree of rotundity or curvature of the corners, the figure may be anything from a pure rectangle to an ellipse, and this seems to be the way in which the term is used. In zoölogy and botany the term is permitted a still wider range, as there it is not insisted upon that the two ends of the figure shall be of the same size, as in the case of oblong leaves, etc. The general idea which "oblong" carries is that of length exceeding the breadth, and it is frequently useful, without often conveying wrong impressions. No one may say precisely what the word may be taken to mean, and yet everyone knows very nearly.

(61) R. G. C., Pawtucket, R. I., writes: I had occasion to make a core-box 14 inches long and of a section like Fig. 1, for making two similar cores at once. B. claims that, on account of its being a double box, the two parallel sides *C* must

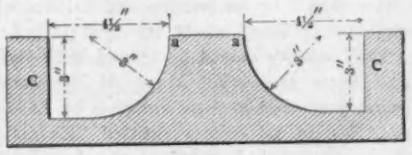


Fig. 1

Fig. 2

have draft to allow the core to draw free, while A. claims that, owing to the 3-inch radius, the two sides *C* can be left up perfectly square, and that there would still be plenty of draft for the core to drop out. Always allowing that a core-box should have draft, which of us is right? A.—We assume that after the core is rammed up, the core and box will be turned over upon a plate, and the box will be drawn from the core, rather than the core from the box. The extreme corner *a* of each core is of course parallel with its side *C;* but these corners would not break, as they would be supported by the plate, and each core individually would have draft or clearance immediately after the drawing was begun. The two sides *C C,* however, of the two cores, being parallel with each other, would have no clearance relatively to each other, and such clearance could only occur by the sliding of one or both of the cores upon the plate. If the two cores were made in the box, as in Fig. 2, a slight lateral movement of the box after the drawing began would of course free both cores, and no draft would be required on the vertical sides.

Personal.

Mr. Lucian Sharpe, Jr., of the Brown & Sharpe Manufacturing Company, is in Europe, where he expects to remain for some months.

W. H. Marshall, formerly of the Northwestern, has been appointed superintendent of motive power of the Lake Shore Railroad.

Mr. W. H. S. Craven, of Craven Bros., machine tool builders, of Manchester, England, who for about a month past has been visiting some of our machinery building establishments, sailed for England on the 17th instant.

It is understood that Charles F. Thompson, secretary, treasurer and director of the Lane & Bodley Company, Cincinnati, has resigned his position in those capacities, to take effect July 1. Mr. Thompson has been with the company thirty-five years. It is not as yet known who will be the successor to Mr. Thompson, nor has Mr. Thompson made up his mind as to what he will do in the future.

At a recent meeting of the Board of Control of the Michigan College of Mines, Professor Fred W. McNair was unanimously elected president of the institution. Professor McNair has been for some years in charge of the department of mathematics and physics, and is a young man of sterling character, fine executive ability, an energetic and successful teacher. The Board and the friends of the institution express great confidence in his ability to maintain the college in the front rank of monotechnic schools.

A Five-Year Course in Engineering.

The ever-increasing pressure for more time in engineering courses of study and the substantial ignoring of general or "culture" studies to which this has led, has resulted in the preparation of a five-year curriculum at the University of Minnesota.

This course is not intended to supersede the regular four years' course, but to offer an alternative in which the work is distributed over a longer period, thus giving opportunity for additional literary and scientific study. The arrangement as regards degrees is to award the degree of B. S. in Engineering at the end of four years and to give an additional degree of M E., C. E., or E. E. at the end of the five years.

There is a considerable number of students who lament the absence of studies other than those which are either strictly technical, or preparatory thereto, from the regular courses, and while post-graduate work meets the want in a measure, it is obvious that a five-year course, laid out in advance, provides a better adjustment of the whole time than an extra year can be made to do.

The Bicycle Trade in Canada.

The following report regarding the condition of the bicycle industry in Canada has been received from the United States consul at Hamilton, Ont.:

"From the tables of the trade and navigation of the Dominion of Canada for the year ended June 30, 1898, recently issued, may be gathered some data of interest to the manufacturers of bicycles in the United States. The total number of bicycles sold in Canada during the year is estimated at 50,000, of which 27,262 were imported from the United States and 46 from Great Britain. In addition to this large importation of complete machines, the value of bicycle parts imported was $279,752 (of which the United States furnished $271,175), which is held to represent 12,000 complete machines at $27 each. In round numbers, the total of imported bicycles sold, complete or in parts, was 40,000, averaging in cost $22.20, on which a duty of 30 per cent. was assessed and $179,259 collected, while on bicycle parts the duty collected was $83,534.

"In 1897, the importation of completed bicycles was 24,558, or 2,750 less than in 1898. The average cost in 1897 was $32.40, against $22.20 in 1898; and the duty, per machine, $9.72, against $6.66. These figures show that as the American manufacturer decreases the cost, the demand increases.

"During the year ended June 30, 1898, 18,617 bicycles were manufactured in Canada, of which only about 10,000 were sold at home. While the United States was encroaching on this market, Canadian manufacturers were reaching out for the trade in foreign countries, and sold 8,617 bicycles for $373,383; Australia taking 5,229, Germany 1,441, Great Britain 616, France 490, and the United States 307, as their largest customers.

"The prices seem to have been varied for each country, as follows: Great Britain and Australia, about $46; France, about $41; United States, about $35; Germany, about $30."

Examination for Instrument Maker for U.S. Naval Observatory.

The United States Civil Service Commission announces that on July 11, 1899, examination will be held at any city in the United States where the Commission has a Board of Examiners, for the position of instrument maker, United States Naval Observatory (Navy Department). The subjects of the examination and the weights given them will be as follows:

Subjects.	Weights.
(1) Letter-writing	10
(2) Practical questions relative to the construction and mechanical operation of telescopes of the larger sizes	90
Total	100

(*Continued on page 41.*)

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant ; see p. 16.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Forming lathes. Mer.Mach.T.Co.,Meriden,Ct.

Light and fine mach'y to order ; models and elec. work specialty. E. O. Chase, Newark, N. J.

Book "Dies and Diemaking," price $1, post paid. J.L.Lucas,Prov.,R.I. Send for index sheet.

"Brandt's Triple Expansion Gaskets" are the best for boilers. Randolph Brandt, 38 Cortlandt st., New York.

Second-hand books, cheap ; scientific, mechanical, miscellaneous ; catalogs free ; send postal for one. Industrial Pub. Co., 16 Thomas st., New York.

Bound volumes of "American Machinist" for 1893 and 1894, cloth, good condition, $3 each ; one of 1888, morocco, $4. "Volumes," care AMERICAN MACHINIST.

The Waltham Machine Works, Waltham, Mass., make a specialty of accurate work. Correspondence in regard to small automatic machinery, punches and dies, etc., is solicited.

Wanted—One hand traveling crane, approximate length 48 feet over all, capacity 35,000 pounds. Address, with full particulars and price, Swift & Co., Union Stock Yards, Chicago.

For Sale—Foundry and machine shop, having 300 ft. front, with water power, doing a profitable business in the Northwest ; to a party with about $5,000 a good opportunity. Box 60, AMERICAN MACHINIST.

For Sale—Type factory building, 25x41 ft., 26 acres of land ; stock, tools, fixtures and machinery for making hard metal type for writing machines ; property of the late A. M. Howard ; cheap for cash. A. M. Sanderson, Enfield, Mass.

Institutions retiring from business having machine tools, brass or wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

For Sale—One 15 H. P., 10x12, 150-revolution, O. K. Rider's patent engine ; one 30 H. P., 9x20, 200-revolution New York Safety engine, and one 45 H. P., 10x20, 110-revolution Twiss patent engine ; the above engines in first-class condition, and can be seen running at Kennedy Valve Mfg. Co., Coxsackie, N. Y.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisement under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded ; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents.

Situations Wanted.

Smart draftsman wants position ; 6 years' experience ; shops practice ; any district. Box 61, AMERICAN MACHINIST.

Foreman tool maker wants position ; experienced on all kinds of small tools. Address Box 65, AMERICAN MACHINIST.

Technical mechanical draftsman ; 5 years' experience ; capable of taking charge of drawing room. Box 62, AMERICAN MACHINIST.

Situation wanted as business manager of gasoline engine works ; 6 years' experience in leading company. Box 44, AMER. MACHINIST.

Technical graduate, 12 years' experience, wants head of manual training school or N. Y. manufacturer's agency. Address Box 50, AMERICAN MACHINIST.

Blacksmith, young man, age 27, desires to change ; used to heavy or light machinery work ; must have steady employment. Box 55, AMERICAN MACHINIST.

Foreman of iron foundry will change ; wanted, shop on special work, machinery ; first-class reference ; experienced. Address Box 64, AMERICAN MACHINIST.

All-round machinist, 10 years' experience, technical student, married, wishes permanent position July 1, with firm building printing presses, marine or Corliss engines ; references furnished. Box 51, AMER. MACHINIST.

Help Wanted.

Wanted—A first-class working foreman for a pump shop. Box 58, AMER. MACHINIST.

Wanted—Foreman for tool room and general repair work ; state age, experience and wages expected. Box 56, AMER. MACHINIST.

Wanted—Draftsman familiar with large vertical engine design. Address, stating references and salary, P. O. Box 452, Pittsburgh, Pa.

Several first-class tool makers wanted on light interchangeable work ; state age, experience and wages expected. Box 28, AMERICAN MACHINIST.

Salesman, to represent tool and supply house in New York and nearby territory. Address, stating experience and salary wanted, Box 57, AMERICAN MACHINIST.

Wanted—Draftsman, experienced in boring and turning mill design ; preference to one who could join in construction plant on modern lines as specialty. Address Box 63, AMERICAN MACHINIST.

Wanted—Superintending manager for large establishment ; must be competent to take charge from drafting room to finished product. Address, stating references and experience, Box 53, AMERICAN MACHINIST.

Wanted—Machinists who have had experience on high-grade machine work ; if you are not accustomed to accurate work, do not answer ; state experience, age, wages, references and address. Box 52, AMER. MACH.

Superintendent wanted, to take charge of gun factory employing 40 men, in a New England village ; must be familiar with gunmaking in its details ; state age, experience and wages. Address Box 41, AMER. MACH.

Wanted—One good vise-hand machinist and one tool maker experienced on punches and dies for stamped-steel work ; state experience, wages expected and give references. Address Williamsport Staple Company, Williamsport, Pa.

Wanted—First-class man to take charge of screw machines (hand machines only), who is competent to figure on work ; also first-class man on punching and forming dies ; pay, $3 per day for nine hours' work. Box 59, AMERICAN MACHINIST.

We are enlarging our works, and will shortly require an increased number of skilled mechanics ; we invite applications from draftsmen, pattern makers, molders and machinists. Address the Westinghouse Machine Company, East Pittsburgh, Pa.

Wanted—Swedish tool maker who has been working on bicycle tools, dies and fixtures, and who is accustomed to handling men, for a bicycle shop in Stockholm, Sweden, as foreman and assistant superintendent ; state salary, experience and give reference. Box 43, AMERICAN MACHINIST.

Wanted—Foreman for jobbing machine shop ; must be familiar with approved shop methods and with tools, and must have experience in handling men ; none without these qualifications and the ability to turn out miscellaneous work economically need apply. Box 66, AMERICAN MACHINIST.

Wanted—A foreman familiar with laying out structural ironwork and one competent to make estimates and handle men in a shop building an established line of machinery ; none but a sober, steady, reliable man need apply ; steady employment and a good situation for a hustler ; state wages wanted. Address Box 596, Anderson, Ind., or Box 54, AMERICAN MACHINIST.

The CROSS OIL FILTER

actually reduces oil bills 50% or more. Sent on approval. Capacities 3 to 150 gals. per day. Used in 23 countries. Testimonials from the leading firms in every field of industry.

THE BURT MFG. CO.
AKRON, OHIO, U.S.A.
Business Established 9 Years.
Largest Manufacturers of Oil Filters in the World.

(Continued from page 40.)

From the eligibles resulting from this examination certification will be made to fill the position of instrument maker at the Naval Observatory, Navy Department, at a salary of $1,500 per annum.

This examination is open to all citizens of the United States who desire to compete. They will be examined, graded and certified with entire impartiality, and wholly without regard to any consideration save their ability as shown by the grade given them in the examination.

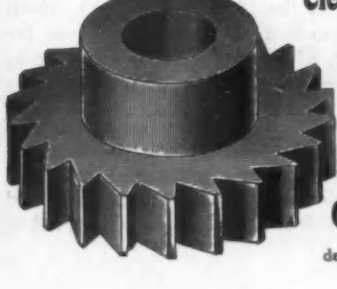
Persons who desire to compete should at once apply to the United States Civil Service Commission, Washington, D. C., for application blank (Form 304), which should be properly executed and promptly filed with the Commission at Washington, D. C.

Charles Churchill & Co. in Glasgow.

Charles Churchill & Co., of London, inform us that they have opened a warehouse and salesroom in Glasgow, at 52 Bothwell street. They occupy the ground floor and basement of a new building, 80x24 feet, put up by the Coates thread people, who occupy the upper floors as offices. Here Messrs. Churchill propose to carry a stock of American tools and supplies, and will be enabled to better attend to their growing business in Scotland.

An extensive chart of Russia is to be exhibited at the Paris Exposition, on which will be shown the extent of different trades in Russia. The chart will be prepared by a commission appointed by the pedagogical department, and will show the different trades taught in the Russian schools, such as wood carving, mechanical work, art, etc. This chart is expected to be of great interest, as it will show the degree of progress made in that country.

A course of twelve free lectures on applied electricity is being given in the Lecture Room, adjoining the New York office of the International Correspondence Schools, 14 East Seventeenth street, this city. The opening lecture was delivered last Thursday, June 15, and will be followed by one each succeeding Thursday at 8 P. M. until August 31. Further particulars may be obtained by application at address given above.



Cleveland Gear Works
W. E. SAWYER, Lessee.
86 Seneca St., Cleveland, Ohio.
GEARS of all descriptions.

Autogo, But Won't.

It was an automobile,
Began to balk and rant,
And when 'twas told to move on, said,
"I auto, but I shan't!"
—"Harper's Bazar."

The town of Nicolaiev, Russia, contemplates the installation of a complete water works system and bids for the same are to be received from either natives or foreigners until about September 15. The supply must be about 2,000,000 gallons per day of 18 hours. Two compound condensing pumping engines, a water tower, 329,000 feet of pipe, valves, etc., will be required. Mr. V. A. Datsenko is mayor of Nicolaiev.

One of the boldest of engineering schemes is that of the proposed tunnel between England and Ireland. It would be 25 miles long and under 500 feet of water. The depth and not the length would be most likely to defeat the enterprise. If water was encountered in large volume it, of course, could not be held back in the usual way by compressed air, as men could not work under the pressure.

The United States Geological Survey has published a map of New York and vicinity which is of the first order of excellence, and shows contours as well as other natural and artificial features. It is sold at the cost of printing, and may be had by addressing H. C. Rizer, Acting Director, United States Geological Survey, Washington.

A contract for two new vessels for the International Navigation Company has been placed with the Cramp Engine & Shipbuilding Company. The speed called for is 17 knots. Each of the steamers is to be of 12,000 tons register, and will have twin screws driven by triple-expansion engines. They will be 600 feet long, with 60 feet beam.

When it was first proposed to use cast-iron pipes for water service in London, where they were employed in 1816, they were objected to by some of the wiseacres of that day because water conveyed through them would produce cancer.

The new wage scale for puddlers and finishers in the Pittsburgh district, which goes into effect July 1 and continues for one year, advances the wages of 45,000 to 50,000 men 25 per cent.

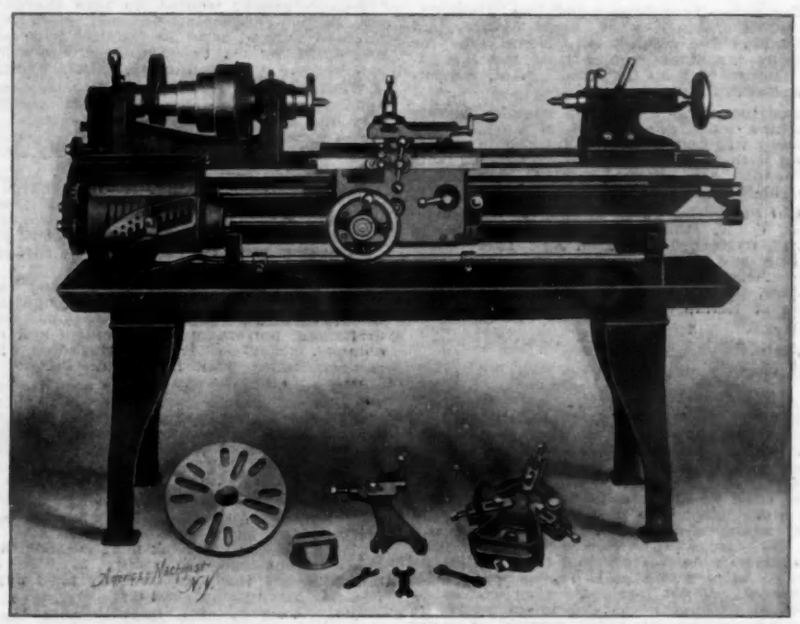
All the machinery, guns and war material have been removed from the repair ship Vulcan, now at the League Island Navy Yard, and she is to be sold at public auction.

The Hendey Machine Co.

TORRINGTON, CONN.

This Company is the sole owner of Letters Patents Nos. 468,183, 470,591, 519,294, 549,006 and 557,031, granted to P. & W. Schellenbach, W. P. Norton, and W. L. Schellenbach, for Improvements in Engine Lathes.

We take this method of notifying the public that we have already commenced suit against infringers of these patents, and that should it be found necessary to the protection of our rights, additional suits will be brought against manufacturers, vendors and users of infringing lathes.



The merits of these improvements have been widely recognized and have been wantonly copied. We shall take vigorous steps to protect our own.

The Hendey Machine Co.,

TORRINGTON, CONN.

UNITED STATES AGENTS:

Hill, Clarke & Co., Boston. Manning, Maxwell & Moore and The Garvin Machine Co., New York. J. W. Cregar, Philadelphia. U. Baird Machinery Co., Pittsburgh. The E. A. Kinsey Co., Cincinnati. Manning, Maxwell & Moore, Chicago. Pacific Tool & Supply Co., San Francisco.

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